

A randomized controlled trial of a mobile ecological momentary stress management
intervention for students with and without a history of emotional abuse

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Dedication

This dissertation is dedicated to all individuals seeking recovery and resources in the aftermaths of their traumas. I also dedicate this dissertation to all of the participants who gave their energy and openness to my research, as it would not have been possible without all of you.

Abstract

College can be a stressful period of life, in which a history of interpersonal trauma is associated with greater risk of distress. Specifically, students with a history of childhood emotional abuse report more distress despite the lack of research on emotional abuse. Thus, it is imperative to develop interventions to help reduce distress in this population. One novel approach involves ecological momentary interventions (EMIs), which use mobile phone platforms to deliver near-real-time psychosocial interventions in daily life and can increase access to psychotherapeutic care. This study is the first randomized controlled trial to examine the feasibility and efficacy of an EMI for reducing psychological distress among students with and without an emotional abuse history. For 14 days, participants ($N = 382$) were randomly assigned to receive: 1) the EMI that teaches stress management skills or 2) an ecological momentary assessment (EMA), a self-monitoring control condition with assessments only. Participants completed pretest, posttest, and three-week follow-up measures. Linear mixed models indicated that there were no significant condition-by-time interaction effects, suggesting that changes over time occurred regardless of condition (EMI vs. EMA). There were different levels of EMI efficacy depending on emotional abuse history, in that the EMI was generally more effective for those with a history of emotional abuse and the EMA was more effective for those without such a history. Overall, the EMI appeared feasible, acceptable, and usable, although less effective than web-based versions. Because of this, college counseling centers might rather streamline resources to further promote web-based interventions.

Future interventions could also target certain at-risk groups, based on their trauma history or baseline levels of distress.

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College can be a stressful time of life; nearly half of females and a third of male college students in one sample reported feeling that they were not able to control the important things in their life and that difficulties were too much to overcome (Saitz et al., 2007). The American College Health Association's National College Health Assessment (2017) found that 88% of college students reported feeling overwhelmed by all that was expected of them at some point in the past year, with 62% of all respondents stating that they felt overwhelming anxiety and 40% feeling so depressed that it was difficult to function. Additionally, a multisite study of college students (Frazier et al., 2009) found that more than 80% of undergraduates had experienced a potentially traumatic event in their lifetime, including bereavement, motor vehicle accidents, and interpersonal traumas.

The aftermath of such events as well as the inherent stress of college life can be academically detrimental. Depression and other mental health conditions can negatively impact academic functioning, putting students at risk of drop out (South, Haynie, & Bose, 2007) and poorer academic performance (Andrews & Wilding, 2004). These mental health problems may uniquely arise during the college period, as one longitudinal study found that some symptom-free high school students reached clinically significant levels of depression (9%) and anxiety (20%) shortly after beginning college (Andrews & Wilding, 2004). College students report that stress (34%) and anxiety (26%) are the most common factors that affect their individual academic performance (ACHA, 2017). Thus, it is imperative to find strategies and develop interventions to help reduce distress among

college students in this critical period. My proposed study aims to elucidate the long-term effects of emotional abuse on current functioning at baseline and examine whether an ecological momentary intervention (EMI) helps reduce psychological distress among students with a history of emotional abuse (which are about 11-25% of individuals, depending on the sample and measure; Anda et al., 2006; Nguyen-Feng, Baker, Merians, & Frazier, 2017; Spertus, Yehuda, Wong, Halligan, & Seremetis, 2003).

Perceived Control

One skill that appears particularly helpful in reducing distress among college students is present control. The construct of present control (Frazier, Berman, & Steward, 2001) involves focusing on aspects of events that are currently under one's control (e.g., thoughts and feelings about a stressful situation) rather than on what one could have done (past control) or can do to prevent an event from happening again (future control). One's perception of the controllability of an event is also more important than the objective amount of control one may have (Frazier & Caston, 2015) in terms of lower psychological distress. In addition, event specific measures of perceived control predict outcomes beyond general measures (Frazier et al., 2011a).

Of the different aspects of the temporal model of control (i.e., past, present, future control; Frazier et al., 2001), only present control has been found to be consistently associated with less current distress, with medium to large effect sizes, even after controlling for a host of known correlates of adjustment such as neuroticism, coping strategies, social support, prior traumas, and general locus of control beliefs (e.g., Frazier et al., 2011a; Frazier et al., 2012). Past control is consistently unassociated or positively

related to distress; the evidence for future control and its relation to distress is mixed, as future control is only related to less distress when the event is controllable (Frazier & Caston, 2015). Thus, perceived present control appears to be a uniquely potent skill. This also suggests the clinical importance of developing interventions that target present control to reduce distress.

Web-based Interventions

Previous research has attempted to translate the concept of present control into a teachable skill via a web-based intervention, which are generally considered equivalent to face-to-face therapies (for a review, see e.g., Carlbring, Andersson, Cuijpers, Riper, & Hedman-Lagerlöf, 2018). This particular psychoeducational web-based intervention focusing on increasing present control has been found effective in reducing anxiety, depression, and stress symptoms in seven randomized clinical trials (see Table 1). Across studies, the intervention typically consisted of three modules, each containing a psychoeducational video of an expert discussing aspects of stress and present control, an animated video using Prezi containing examples from other students regarding the lesson content, and a written exercise. Module 1 described research on stress and its effects on college students' mental and physical health as well as academic performance. Module 2 discussed different aspects of control and the benefits of present control. Module 3 discussed problem solving around focusing on present control. The written exercises asked students to apply the lesson content to their own lives. For example, the Module 1 written exercises asked students to examine how stress has affected them emotionally and physically and how it has affected their relationships and school performance. After

completing the modules, participants completed written exercises that involved writing about the current stressors in their lives, what aspects of those stressors were controllable and uncontrollable, the actions they could take regarding the controllable aspects, and (after the first written exercise) what had changed about the stressors as a result of the actions they had taken.

Three of the clinical trials on this web-based present control intervention were conducted with community college students (Frazier et al., 2015; Meredith & Frazier, 2017), including one sample of community college students in a required college readiness course (Meredith, 2016); three were with university students (Nguyen-Feng et al., 2015; Nguyen-Feng et al., 2016; Nguyen-Feng, Greer, & Frazier, 2017), and one was with preselected university students who scored low on a measure of present control (Hintz, Frazier, & Meredith, 2015). See Table 1 for a summary of these studies' findings.

Testing the web-based intervention first began with university students who scored low on present control ($N = 233$; Hintz et al., 2015). Participants were randomly assigned to receive the present control intervention, the present control intervention with feedback on their exercises, or stress management information only. The two intervention groups reported significant decreases in perceived stress and symptoms of stress, depression, and anxiety with small to medium within-group effect sizes at postintervention (average $d = -0.30$) and three-week follow-up (average $d = -0.46$). The two intervention groups (averaged together) also had greater reductions in distress relative to the stress management information only group at postintervention (average $d = 0.30$) and follow-up (average $d = 0.35$).

The present control intervention was then further tested on community college students. In the first of these studies (Frazier et al., 2015), a sample of 194 community college students was randomly assigned to receive the present control intervention (without feedback) or the stress management information only condition. Effect sizes for reductions in distress were similar to Hintz et al. (2015) at postintervention (within-group $d = -0.34$; between-group $d = 0.35$). At the three-week follow-up, although the average within-group effect size was similar to Hintz et al. ($d = -0.49$), unexpected reductions in distress among the stress management information group led to a small between-group effect size ($d = 0.12$). Nonetheless, mediation analyses suggested that increases in present control were the mechanism of change for both the university students (Hintz et al., 2015) and the community college students (Frazier et al., 2015).

Present Control Intervention: Additions and Improvements

To potentially enhance the effects of the present control intervention, different versions of the intervention were developed. One study with community college students (Meredith & Frazier, 2017) consisted of the following conditions: the original present control intervention, an enhanced present control intervention, and a present control and mindfulness intervention. The enhanced version of the intervention was similar to the original except that it involved participants writing more details in their written exercises based on Solie (2013). Specifically, after creating a list of items that were inside of their control, they selected which items that they wanted to do, prioritized the actions that they would take, and were asked to select a scheduled timeframe to accomplish the action. Participants were asked to focus on the priority that they chose to address in the moment

and to let go of what was outside of their control. According to one definition, mindfulness is “paying attention in a particular way: on purpose, in the present moment, and non-judgmentally” (Kabat-Zinn, 1994, p. 4). In the present control and mindfulness condition, participants watched a four-minute psychoeducational video on mindfulness, completed mindfulness exercises, and rated how fully they were able to experience thoughts and feelings over the past week. These activities replaced the written exercises on present control completed in the original present control intervention. The mindfulness exercises involved listening to three 8- to 12-minute mindfulness meditation audio files that taught breath awareness and noticing emotions that arise. After the mindfulness exercises, students completed a short, written mindfulness log in which they noted what thoughts and feelings arose for them during the activity.

In the community college student study (Meredith & Frazier, 2017), participants ($N = 213$) were randomly assigned to one of the aforementioned three conditions (the original, an enhanced version, or present control and mindfulness). As a preliminary study testing two new versions of the intervention, it was underpowered to detect small between-group differences but rather had a “learning then confirming” (Lee, Whitehead, Jacques, & Julious, 2014, p. 1) goal. In other words, the goal was to gather preliminary data with regard to whether the new versions of the intervention were more effective than the original version. At postintervention, the present control and mindfulness group had lower levels of perceived stress (within-group $d = -0.57$) than the other two conditions (original present control intervention: within-group $d = -0.34$; enhanced present control intervention: within-group $d = -0.29$), though all three conditions appeared equally

effective for the other measures. At three-week follow-up, there were no between-group differences in outcomes though within-group effect sizes were moderate to large (d s = -0.44 to -0.65). Overall, all intervention conditions appeared to be effective in increasing present control and decreasing distress, with no one intervention condition being more consistently better than another.

A follow-up study (Meredith, 2016) with community college students in a required college readiness class tested whether receiving feedback messages would be helpful relative to the intervention without feedback and a comparison group. Feedback consisted of receiving personalized emails with encouraging messages regarding a participant's written exercises and study involvement (e.g., "Congrats on finishing Module 2. You did a great job on the present control exercise. You are right, you do not have control over how much homework is given to you. You do have control of how much homework you do, and when you do it"). Participants ($N = 527$) were randomly assigned to one of three conditions: the original present control intervention, the present control intervention with supportive messages, and a comparison group. Findings from this study were different from the other studies of the present control intervention. Between-group differences in outcome measures were small at postintervention and at three- and six-week follow-ups, d s = -0.08 to 0.25. Similar to findings from other studies (see Schueller, Aguilera, & Mohr, 2017, for a review) and another study that employed the present control intervention (Hintz et al., 2015), there were no significant differences among those who did and did not received feedback.

In addition to assessing differences in efficacy between conditions, these studies provide information regarding potential differences in intervention adherence across conditions. Specifically, there were no statistically significant differences in task completion among the three conditions in the community college student study (Meredith & Frazier, 2017) or a three-arm university student study (Nguyen-Feng et al., 2016) that compared different versions of the present control intervention. This indicates that adherence looks similar regardless of the type of tasks that participants are asked to complete in studies where there are only active intervention arms. However, in controlled studies, there tend to be slightly higher adherence rates in active comparison groups (e.g., reading information on stress management) than in the interventions arms that teach and encourage practice on stress management skills (e.g., Frazier et al., 2015; Nguyen-Feng et al., 2017b). In a study that compared receiving feedback versus not receiving feedback (Meredith, 2016), participants who received supportive messages completed more tasks than those in the original or comparison conditions, despite a lack of difference in treatment outcomes. This demonstrates that receiving feedback and supportive messages can increase study adherence, though clinical outcomes do not differ. This is also consistent with other research demonstrating that attrition (Zagorscak, Heinrich, Sommer, Wagner, & Knaevelsrud, 2018), accountability, and engagement (Mohr et al., 2013) may change with feedback irrespective of treatment outcomes.

Present Control Intervention: Interpersonal Trauma History as a Moderator

In addition to developing and comparing different versions of the intervention, other studies have examined whether individual characteristics moderate the

effectiveness of the intervention. For instance, the present control intervention may be differentially effective for students with a history of interpersonal trauma (e.g., childhood and adult sexual victimization, witnessing family violence) than for those without such a history (Nguyen-Feng et al., 2015; Nguyen-Feng et al., 2016; Nguyen-Feng et al., 2017b). Specifically, because those with a history of interpersonal trauma are at risk for more distress (Frazier et al., 2009) and because the temporal model of control was developed from research with sexual assault survivors (e.g., Frazier, 1990, 2000, 2003; Frazier, Tashiro, Berman, Steger, & Long, 2004), an intervention focused on teaching present control skills may be particularly beneficial for those with such a history. If the present control intervention is more effective for those with an interpersonal trauma history, it would indicate that teaching present control skills to those who report such experiences is particularly important.

In one randomized controlled trial (Nguyen-Feng et al., 2015), students were randomly assigned in a 2:1 ratio to either the present control intervention ($n = 329$) or waitlist ($n = 171$) condition. History of interpersonal violence was assessed at preintervention and reported by 39% of the sample, in which witnessing family violence (25%) and experiencing uninvited sexual attention (20%) were the most frequently reported. At preintervention, those with an interpersonal violence history reported higher baseline levels of perceived stress, stress symptoms, and anxiety than those without such a history. Those with and without a history of interpersonal violence reported similar levels of depression and present control at baseline. Although the overall effect of the intervention was significant, with the intervention group reporting less distress than the

waitlist group at postintervention on all measures, the effects were significantly larger for those with a history of interpersonal violence (between-group $d = -0.44$) than for those without this history (between-group $d = -0.10$). The interaction between interpersonal violence status and condition was significant for all outcome measures (depression, anxiety, and perceived stress) except for stress symptoms. An example of this difference is that those with an interpersonal violence history in the waitlist condition increased in their levels of anxiety from pre to postintervention ($d = 0.15$) whereas those in the intervention condition decreased in their levels of anxiety ($d = -0.28$) over the course of the intervention so that their postintervention scores were similar to those without a history of interpersonal violence. This suggests that an intervention to increase present control may be particularly effective for this at-risk group.

In a follow-up study (Nguyen-Feng et al., 2016), the present control intervention was tested alongside the two new, improved versions: the present control intervention with a mindfulness component and the enhanced version of the present control intervention (see also Meredith & Frazier, 2017). Students ($N = 314$) were randomly assigned to one of these three conditions (the original intervention, an enhanced version based on Solie [2013], or present control and mindfulness). Interpersonal violence history was measured at baseline and reported by 35% of the sample. Similar to Meredith and Frazier (2017), this study was underpowered to detect small between-group differences. However, trends in the effect sizes among the three conditions suggested that the two new versions were more effective than the original given their consistently larger effect sizes across the outcome measures (see Table 1). There were also

significant interactions of condition and interpersonal violence status for the composite distress variable (depression, anxiety, stress symptoms) and worry although this interaction was not significant for perceived stress. Specifically, the enhanced version appeared to be most effective among those with an interpersonal violence history, demonstrated by its average with-in group effect size ($d = -0.48$), which was larger than the average within-group effect sizes of $d = -0.26$ and $d = -0.34$, respectively, for the original present control intervention and present control plus mindfulness. Among those without an interpersonal violence history, the average within-group effect sizes were $d = -0.17$ for the original present control intervention, $d = -0.39$ for present control plus mindfulness, and $d = -0.37$ for the enhanced version.

One other study examined interpersonal trauma history as a moderator of intervention efficacy (Nguyen-Feng et al., 2017b). In this study, university students ($N = 365$) were randomly assigned to one of three conditions: present control and mindfulness, mindfulness only (e.g., mindfulness audios, videos, and logs administered with all present control components removed), or stress management information only. In the stress management information only condition, participants received a link to resources on the university's counseling center website (e.g., psychoeducation sheets on various ways to manage stress). Participants were tasked with reading the website and verifying that they spent at least five minutes in the past week reviewing the stress management tips. Measures of distress were completed at preintervention, postintervention, and two follow-ups (2-3 and 4-5 weeks postintervention). The three interventions were equally effective in reducing distress across the time points; however, when interpersonal trauma history

was examined as a moderator, the present control and mindfulness and stress management information conditions were more effective than the mindfulness only condition. That is, mindfulness skills alone did not reduce distress among interpersonal trauma survivors ($d = -0.03$), but the addition of present control skills was associated with a larger effect size ($d = -0.35$). This line of research suggests that present control is particularly useful for those with a history of interpersonal trauma, in which additions to present control (e.g., enhanced present control written exercises, mindfulness) may add to intervention effectiveness.

Overall, a web-based intervention that focuses on teaching present control appears to be effective in reducing distress for university students (e.g., Hintz et al., 2015) and community college students (e.g., Frazier et al., 2015; Meredith & Frazier, 2017). Intervention effectiveness appears to be affected by whether students successfully learn the concept of present control, as increases in present control appear to mediate the relationship between intervention condition and reduced distress (e.g., Hintz et al., 2015). Furthermore, present control as a skill is particularly important, as a mindfulness condition delivered without teaching present control (within-group $d = -0.03$) was not as effective in reducing distress relative to a condition combining present control and mindfulness (within-group $d = -0.35$) for survivors of interpersonal violence (Nguyen-Feng et al., 2016). Interpersonal trauma history also appears to be a potentially important moderator, given that the intervention was more effective for students with such a history (between-group $d = -0.44$) than for those without (between-group $d = -0.10$; Nguyen-Feng et al., 2015). Regardless of potential moderators and adaptations of the original

intervention, these seven randomized clinical trials demonstrate that a web-based present control intervention is a useful resource for students.

These results are consistent with reviews examining the efficacy of web-based stress management interventions in adults. In a meta-analysis (Heber et al., 2017), web-based stress management interventions outperformed control groups at posttest with small effect sizes for both depression ($d = 0.43$) and anxiety ($d = 0.34$). Among college students, a review (Conley, Durlak, & Dickson, 2013) demonstrated that web-based programs that teach skills and include supervised practice had the strongest benefits in decreasing emotional distress. Specifically, teaching mindfulness and cognitive-behavioral techniques appeared most effective. Other reviews with college students have produced mixed results, finding that 29% (15 out of 51 studies) had no significant effects (Farrer et al., 2013) or that significant results were primarily only in comparison to inactive controls (Davies, Morriss, & Glazebrook, 2014). However, these reviews included all randomized controlled trials rather than focusing on skill-oriented programs only (c.f., Conley et al., 2013), which is the focus of the web-based present control intervention.

Emotional Abuse

Childhood emotional abuse, which has been defined as “verbal assaults on a child’s sense of worth or well-being or any humiliating or demeaning behavior directed toward a child by an adult or older person” (Bernstein et al., 2003, p. 175), is important to explore as another moderator of intervention efficacy for several reasons. First, the long-term impacts of experiencing childhood emotional abuse seem to occur at even the

molecular level. For instance, women with a history of childhood emotional abuse had particularly low levels of cerebral spinal fluid oxytocin (Heim et al., 2009), a neuropeptide that is positively associated with attachment, social support, and trust as well as protection against stress and anxiety symptoms. Second, several authors have noted that research on emotional abuse is lacking relative to other forms of abuse (Burns et al., 2010; Lowell et al., 2014). In particular, research with college student samples is limited compared to research on childhood emotional abuse in the community despite near equivalent rates of childhood abuse (Wright, Crawford, & Del Castillo, 2009). According to Lowell et al., understanding these childhood experiences may help inform intervention and prevention efforts. Despite its clear importance, emotional abuse has been called the “most hidden, under-reported, and least studied” (Wright et al., 2009, p. 60) type of abuse; emotional abuse appears particularly hidden among college students, as they are seen as a higher functioning group.

Given that the aforementioned present control intervention studies found interpersonal trauma to be a moderator, childhood emotional abuse warrants exploration as a potentially important moderator of the effectiveness of the present control intervention. The idea that teaching present control is effective for those with a history of interpersonal trauma seems fitting, as it is in line with theoretical models of anxiety development that highlight the relation between uncontrollable events in childhood and later perceptions of the uncontrollability of events (Chorpita & Barlow, 1998). The aforementioned present control intervention studies that examined interpersonal trauma as a moderator (e.g., Nguyen-Feng et al., 2015) did not specifically assess emotional

abuse and grouped various forms of interpersonal traumas together despite differences between trauma types.

Studies that have examined differences between various forms of trauma indicate that different trauma histories predict different reactions to daily stressors and distress. For example, in a daily diary study of undergraduate students (Baker, Nguyen-Feng, Nilakanta, & Frazier, 2018), those with a history of childhood emotional abuse reported experiencing more daily stressors, perceived less control over their daily stressors, and used less effective coping strategies than other students, including those who had experienced sexual victimization. Emerging evidence suggests more that more research is needed on emotional abuse, particularly as childhood emotional abuse is more strongly related to distress (e.g., Burns, Jackson, & Harding, 2010) and more common than other types of abuse (e.g., Lowell, Renk, & Adgate, 2014), with one study estimating it as twice as common as sexual abuse (Burns et al., 2010).

Mechanisms of Change: Present Control, Coping, Mindfulness, and Rumination

To understand the relation between emotional abuse and distress in a manner that will help inform future intervention and prevention efforts, it is important to more clearly examine the mechanisms linking childhood emotional abuse to distress. This will additionally help researchers develop more specific theories about the effects of trauma such as emotional abuse, as it is important to understand how unique types of adversities exert their effects. With regard to interventions, it is important to know which factors may be particularly relevant for individuals exposed to different events. The aforementioned web-based interventions teach skills to increase present control and

mindfulness, and in turn decrease avoidant coping and rumination. Though studies have not explicitly examined each of these factors as mechanisms for change, there is evidence that emotional abuse is related to each of these mechanisms. Each of these proposed mechanisms of change as well as its relation to emotional abuse will be explored in turn below. By understanding the mechanism linking emotional abuse and distress, interventions may focus on teaching these specific factors and thus reduce distress. In turn, the relation between a web-based intervention and decreased distress may be better understood.

Perceived control. Overall, there is limited research on the relations between emotional abuse and perceived control, despite theoretical models of anxiety development that focus on perceived control (Chorpita & Barlow, 1998). Data from a previous study with college students ($N = 268$; Nguyen-Feng et al., 2017a) indicated that higher scores on a continuous measure of emotional abuse were correlated with lower present control ($r = -.19, p < .01$). Furthermore, in an independent-groups t -test, those with a history of emotional abuse ($n = 72$) reported less present control at baseline than those without such a history ($n = 196$), $t(241) = 3.17, p < .01$, between-group $d = 0.41$. Despite the empirical and theoretical evidence that childhood emotional abuse appears to be related to less perceived control (Irving & Ferraro, 2006; Sudbrack et al., 2015), interventions have not targeted this as a mechanism of change for those with a history of emotional abuse. An intervention that targets increasing present control may also increase students' engagement with their stressors rather than avoiding them; this is related to the process model of perceived control and academic engagement (Skinner,

Wellborn, & Connell, 1990) that demonstrates that perceived control predicts more teacher-rated student engagement.

Mindfulness. There is limited research on mindfulness as a potential mediator of the relations between emotional abuse and distress. However, emerging research indicates that there may be a relation between emotional abuse history and levels of mindfulness. In a sample of community members and students ($N = 163$; Michal et al., 2007), emotional abuse (and emotional neglect, marginally) was inversely related to mindfulness with a small to moderate effect size ($r = -.25$). Additionally, emotional abuse was the only form of childhood trauma that was related to lower mindfulness (compared to physical abuse, sexual abuse, and physical neglect; Michal et al., 2007). In a study that involved both brain imaging and survey data ($N = 19$; Wang, Paul, Stanton, Greeson, & Smoski, 2013), only history of emotional abuse (compared to physical abuse, sexual abuse, physical neglect, and emotional neglect) was significantly inversely related to mindfulness non-reactivity; additionally, individuals with a history of emotional abuse had difficulties in the area of the brain in which amygdala activity is regulated and that is associated with vulnerability for depression. This emerging research suggests that there may be a relationship between emotional abuse and mindfulness, which is the first path that needs to be established when understanding the mechanisms on which an intervention may act.

Similar to the strong negative relation between present control and avoidant coping (e.g., Frazier et al., 2011; Nguyen-Feng et al., 2017a), mindfulness also is inversely related to avoidant coping and is positively correlated with present control

(Nguyen-Feng et al., 2017b). Mindfulness challenges individuals to encounter and more fully experience the emotions and sensations around a distressing situation rather than avoiding them (e.g., Hayes, Luoma, Bond, Masuda, & Lillis, 2006). Multiple studies using various designs (e.g., cross-sectional, longitudinal, daily diary) have demonstrated that mindfulness is inversely related to avoidant coping among undergraduate students in four studies ($Ns = 65-141$; Weinstein, Brown, & Ryan, 2009). In the daily diary study, participants ($N = 70$) were randomly asked to rate their levels of mindfulness three times a day and their experienced stressors and coping mechanisms daily in the evenings. Trait levels of mindfulness were associated with less use of avoidant coping responses with daily stressors. This is consistent with other studies that demonstrate a large negative relationship between mindfulness and avoidant coping strategies (e.g., Palmer & Rodger, 2009).

This relationship between mindfulness and avoidance is also consistent with the acceptance and commitment therapy model of psychopathology (Hayes et al., 2006). According to this model, acceptance, which can be practiced through mindfulness training, is the opposite of experiential avoidance. The ability to commit to new actions and behavioral changes is also the opposite of persistent avoidance. In this model of psychopathology, problems arise in part due to habitual tendencies to avoid negative or uncomfortable “private events” (e.g., emotions, thoughts), which the researchers propose increase the functional importance of such private events (Hayes et al., 2006, p. 7). That is, their link to negativity is strengthened, as the efforts to control the thoughts are associated with attempts to reduce negativity; thus, avoidance is proposed to make

thoughts (and their link to negativity) more salient. An intervention that aims to increase mindfulness may thus also reduce avoidant coping, as the two appear to be inversely related; additionally, such an intervention would build on the literature suggesting that avoidant coping is maladaptive (for a review, see e.g., Aldao, Nolen-Hoeksema, & Schweizer, 2010) and that learning coping skills to regulate emotions is helpful across symptomologies (for a review, see e.g., Sloan et al., 2017).

Meta-analytic findings suggest that mindfulness-based therapy outcomes are comparable to cognitive-behavioral therapies, reduce stress, and improve both mental and physical health (for reviews, see e.g., Goldberg et al., 2017; Khoury et al., 2013; Spijkerman, Pots, & Bohlmeijer, 2016; c.f., Norton, Abbott, Norberg, & Hunt, 2015). The mechanisms underlying the mindfulness-distress link have been studied in the context of different proposed facets of mindfulness. A meta-analysis (Quaglia, Braun, Freeman, McDaniel, & Brown, 2016) of 88 randomized controlled trials examined which dimensions of mindfulness were most related to outcome changes. All studied aspects of mindfulness (i.e., attention, description, nonjudgment, non-reactivity, observation) were related to outcome changes with small to medium effect sizes, with non-reactivity and attention having the largest correlations (mean $r_s = .30$), followed by description and nonjudgment (mean $r_s = .27$), and observation (mean $r = .16$). In a meta-analysis (Gu, Strauss, Bond, & Cavanagh, 2015) of 20 studies, decreases in reactivity to thoughts and emotions was the most consistent and strongest mediator of the relations between mindfulness-based interventions and changes in mental health outcomes. Mindfulness and repetitive negative thinking (e.g., rumination) also emerged in the meta-analysis as

moderate and consistent mediators of the relationship between mindfulness-based interventions and changes in mental health outcomes.

The monitoring and acceptance theory of mindfulness (Lindsay & Creswell, 2016) also seeks to understand the mechanisms behind how mindfulness-based interventions exert their effects. According to this theory, the ability to pay attention to one's emotions and cognitions (i.e., monitoring) while accepting such thoughts and feelings is associated with positive mental health outcomes and emotional regulation. That is, the mechanisms underlying the benefits of mindfulness are not only the confrontation with one's cognitions and emotions, but also the ability to sit with them; monitoring alone is unhelpful but can be helpful if it is paired with acceptance. In a three-arm study that dismantled monitoring and acceptance conditions (Lindsay, Young, Smyth, Brown, & Creswell, 2018), the monitoring and acceptance condition had the lowest levels of cortisol and systolic blood pressure compared to the other conditions (i.e., monitoring only and control) following a social stress test. Thus, a mindfulness intervention that encompasses and teaches both of these aspects (monitoring, acceptance) is important and may be particularly important for an at-risk group of interpersonal trauma survivors. Evidence for the monitoring and acceptance theory of mindfulness is gathered from a multitude of both cross-sectional and longitudinal studies encompassing various populations (e.g., students [e.g., Anicha, Ode, Moeller, & Robinson, 2012], women with anorexia [Adams et al., 2012], police officers [Chopko & Schwartz, 2009], meditators and non-meditators [e.g., Moore & Malinowski, 2009]), although more experimental studies testing this theory need to be conducted.

Avoidant coping. Avoidant coping has been defined as focusing on emotional states without adaptive behaviors and instead disengaging behaviorally and mentally (Carver, Scheier, & Weintraub, 1989). Coping with stress through avoidance may be another manifestation of the negative thoughts and behaviors that can result from emotional abuse. For example, emotional abuse has been found to be related to greater self-criticism (Soffer, Gilboa-Schechtman, & Shahar, 2008; Sachs-Ericsson, Verona, Joiner, & Preacher, 2006), which has been categorized as a form of avoidant coping. Other studies have revealed an association between emotional abuse and other forms of avoidant coping, such as distancing and wishful thinking (Gagné & Melançon, 2013; Krause, Mendelson, & Lynch, 2003). Few studies have examined whether avoidant coping mediates the relation between emotional abuse and distress, though meta-analyses have demonstrated the relation between avoidant coping and psychopathologies (e.g., Compas et al., 2017). Evidence of mediation is important for determining the mechanism of change on which to act, and can inform future interventions. One cross-sectional study (Gagné & Melançon, 2013), which involved adolescents who experienced past-year parental emotional abuse, found that avoidant coping regarding the abuse mediated the relation between emotional abuse and current distress, albeit for girls only. One longitudinal study (Nguyen-Feng et al., 2017a) found that the relation between emotional abuse and current distress was mediated by greater use of avoidant coping with daily stressors; this study, which examined multiple mediators including present control, found that present control did not mediate the relation between emotional abuse and current distress. However, avoidant coping and present control were strongly related ($r_s = -.46$ to

-.70), suggesting that an intervention targeting present control may also decrease avoidant coping. Additionally, an intervention teaching present control skills focuses on more proactive skills rather than simply teaching participants not to use avoidant coping.

Rumination. Rumination is a response style in which individuals think repetitively and passively about their distress symptoms (Nolen-Hoeksema, 2000), akin to brooding. Rumination is related to both present control and mindfulness, as demonstrated in both correlational and experimental studies, which are explored below. Intervention research also suggests the differential effectiveness of a mindfulness condition for those with and without a history of interpersonal trauma. In one randomized controlled trial (Nguyen-Feng et al., 2015), the present control intervention was more effective for those with an interpersonal trauma history than for those without that history; mediation analyses indicated that the intervention may have been more effective for survivors of interpersonal trauma because the intervention decreased rumination in this group only (although both students with and without a history of interpersonal trauma increased in their levels of present control). In one cross-sectional study with university students, mindfulness was negatively correlated with rumination specifically when the thoughts were viewed as uncontrollable (Raes & Williams, 2010). Studies have demonstrated that mindfulness training decreases rumination (e.g., Deyo, Wilson, Ong & Koopman, 2009) and that rumination mediates the relation between mindfulness and trauma symptomology (Im & Folette, 2016). Additionally, rumination mediated the relation between number of trauma exposures (e.g., life-threatening accident, sexual assault) and trauma symptomology and psychological distress (Im &

Folette, 2016). When mindfulness was added as a component to the present control intervention, participants with a history of interpersonal trauma had greater reductions in distress than in the intervention with mindfulness alone and no present control skills (Nguyen-Feng et al., 2017b); thus, the concept of present control appears to be critical in intervention effectiveness. Specifically, it appears important to teach present control with mindfulness skills rather than mindfulness alone

Summary. An intervention that targets these proposed mediators (present control, mindfulness, avoidant coping, rumination) warrants further consideration in an at-risk group of students with a history of exposure to emotional abuse. Efficient ways of reaching students with a history of emotional abuse also are needed, as trauma survivors often do not seek traditional mental health services (for a review, see e.g., Amstadter, Broman-Fulks, Zinzow, Ruggiero, & Cercone, 2009). Despite the potential promise of an intervention targeting present control for at-risk students, it has not been delivered as an EMI, which has the potential to be more effective due to its accessibility in moments of need (e.g., during times of stress). In particular, the effectiveness of the intervention has not been examined in students with a history of emotional abuse, which has emerged as the group at highest risk of current distress in the population of interest, i.e., college students (see e.g., Baker et al., 2018).

Ecological Momentary Interventions

EMIs are a novel approach for delivering psychosocial and health behavior interventions (Heron & Smyth, 2010). EMIs are intended to provide near-real-time psychological support or intervention in daily life (vs. in a clinical setting where

individuals come in to receive psychotherapy once a week) in a manner that is unobtrusive and allows for in situ assessment (Harari et al., 2016). EMIs offer additional components from ecological momentary assessments (EMAs), which are related albeit different in intentions in that EMAs focus solely on observational self-monitoring. In addition to self-monitoring, EMIs also provide supportive or psychoeducational intervention targeted toward a change goal. Similar to EMAs, mobile phones are the primary platform for implementing EMIs, as the majority of the United States population owns a smartphone that they keep on or near their person most of the day (IDC, 2013). Additionally, mobile phones serve as a viable option to gather data from participants at various points during the day. Morning (e.g., for perceptions of sleep quality) and evening (e.g., for reflections on one's day) data collections are feasible, given that 89% of 18- to 24-year-olds check their phones within the first 15 minutes of waking up (IDC, 2013) and that compliance with late evening assessments are high in past EMIs (e.g., 94% at 9 p.m.; Fishbach & Hoffman, 2015). Studies of adherence demonstrate approximately 80-87% compliance across time points (Ben-Zeev et al., 2014; Serre et al., 2012) even for studies with four assessments per day (e.g., 80%; Fishbach & Hoffman, 2015) or at-risk samples (e.g., 80%; EMA with children who have been sexually abused; Simonich et al., 2004).

EMIs have a number of advantages over other psychological interventions (e.g., face-to-face therapy). Because they can be disseminated widely and can be adapted or shared across platforms (e.g., Ben-Zeev et al., 2015), they are more cost effective and can increase the availability of treatments (Armey, 2012; Hedman, Ljótsson, & Lindefors,

2012). They are also much more convenient because they can be completed in one's natural environment rather than requiring transportation to a clinician's office. This decreases resource (e.g., time, finances, transportation) limitations on the client. Finally, they provide support and applied practice in the environment in which they are needed most (i.e., in daily life vs. in a clinical setting) and in the context that is most useful.

EMIs may be delivered in a variety of modalities, including periodic messaging interventions (e.g., text messaging, email; for a review, see e.g., De Leon, Fuentes, & Cohen, 2014), text messaging only (for a review, see e.g., Hall, Cole-Lewis, & Bernhardt, 2015), mobile phone applications (e.g., Ben-Zeev et al., 2014; Burns et al., 2011; Pramana, Parmanto, Kendall & Silk, 2014; Thomas & Bond, 2015), mobile-enabled web-based programs (e.g., Depp et al., 2015), personal digital assistant devices (e.g., Depp et al., 2010; Inada et al., 2016), and palmtop or handheld computers (e.g., Newman, Przeworski, Consoli, & Taylor, 2014; Nollen et al., 2014).

EMIs may also differ in the manner in which they are delivered as well as what content is delivered. For example, the intervention may be delivered based on certain times (e.g., fixed or varied time intervals or specific time of day) or based on certain events (e.g., contextual cues such as location). Across studies the content of EMIs has varied, and has included general behavioral treatments; cognitive-behavioral treatments; general cognitive treatments; or feedback, motivational, or psychoeducational interventions (for a review, see e.g., Beckjord & Shiffman, 2014). Active engagement may also vary (for a review, see e.g., Buchholz et al., 2013), with some EMIs requiring or pulling participants to respond (viz., indialer) and others pushing intervention messages

to the participants (viz., outdialer). EMIs may also be tailored to users in various manners (for a review, see e.g., Heron & Smyth, 2010), including by content, moment of delivery, or baseline characteristics. Uniquely, just-in-time adaptive interventions adjust over time to the individual's time-varying status to try to address the individual's changing support needs (for a review, see e.g., Nahum-Shani, Hekler, & Spruijt-Metz, 2015). Specifically, just-in-time adaptive interventions are “just in time” because they are offered in moments when the participant is vulnerable or moments in which there are opportunities for positive change, assuming that the participant is receptive to support. These interventions are “adaptive” in that there is some form of individuation tailored to the participant, whether it is based on static variables (e.g., baseline participant characteristics, baseline symptom levels) or on dynamic variables that vary with time (e.g., symptom changes). Adaptation may occur at certain decision points and may follow decision rules that determine how individualization occurs.

Across these various methods of delivering EMIs, they appear to be effective in promoting healthy behaviors such as increased physical activity (Buchholz et al., 2013), lower alcohol or substance use (Beckjord & Shiffman, 2014; Mason, Ola, Zaharakis, & Zhang, 2015; Quanbeck et al., 2014), lower nonsuicidal self-injury (Armey, 2012), increased flu vaccination (Szilagyi & Adams, 2012), increased smoking cessation (McClernon & Choudhury, 2013; Spohr et al., 2015), increased weight loss (Servick, 2015), increased diabetes or chronic disease care (e.g., Wang et al., 2014), increased medication adherence, and increased healthy eating (for reviews, see e.g., Hall et al., 2015; Heron & Smyth, 2010). The act of self-monitoring may also help individuals to

identify precipitating events or stimuli and increase awareness of their actions to change their behaviors (Armey, 2012).

Despite the growing support for EMIs and behavioral health change, there are few robust, empirical studies on the effectiveness of EMIs in specifically reducing psychological distress (e.g., symptoms of anxiety and depression); those that exist are only tests of feasibility, are very brief, or involve only basic analyses. For example, Pramana et al. (2014) tested a smartphone application designed to reduce anxiety in children ($N = 9$). The application consisted of notifications, a skills coach (i.e., questionnaires that walked participants through identifying emotions and automatic thoughts and how to problem solve around them), media resources, and a point system in which participants could earn rewards (e.g., stickers, small toys). However, only feasibility, usability, and acceptability were assessed. Wolf et al. (2016) did assess the effectiveness of a text message EMI to assist in mindfulness practices for individuals with depressive symptoms ($N = 21$). For four months, participants received positive reinforcing feedback via text message (e.g., “Great! Try to be kind to yourself while practicing”) when they indicated that they had practiced a mindfulness exercise. The researchers noted simple correlations between the number of text messages participants sent (which they were asked to do after completing a mindfulness exercise) and reductions in depressive symptoms and increases in mindfulness. Instead of using more robust data analytic techniques that can be used with micro-longitudinal data, the researchers simply calculated the difference between pre and postintervention depression

and mindfulness scores and correlated them with the number of text messages sent (depression: $r = -.46$; mindfulness: $r = .23$).

In addition to limitations in the design of the interventions, studies also often employ study designs without randomization or multiple arms. One mobile application for unipolar depression ($N = 8$; Burns et al., 2011) used contextual sensing (e.g., location, ambient light, recent calls) to send tailored feedback such as reminders of therapeutic activity adherence or suggestion of a tool to use (e.g., website), although the study did not have a comparison group. The mobile application had five or more automated prompts sent to the participant's phone daily between 7 a.m. and 10 p.m. either based on the contextual sensing, randomly, or following input from the participant. In addition, there was an interactive website with behavioral skills and didactic trainings that the participants could access. Participants also received email and telephone support. In this single-arm study, participants reported significant reductions in their levels of depression over the course of eight weeks. However, in addition to having no comparison group, the mobile application had technical difficulties due to connectivity issues, reports of the application freezing, drains on cellular battery life, and inaccurate sensory data. Another single-arm study (Mohr et al., 2017) allowed participants ($N = 99$) with clinically significant depression and anxiety to select mobile applications of their choice from a suite of 14 applications designed to reduce their symptoms. These applications focused on a variety of behavioral strategies, including goal setting, motivational prompts, behavioral activation, cognition reframing, relaxation exercises, and sleep diaries to improve sleep hygiene. Participants were asked to focus on one or two applications,

though most (95%) downloaded five or more applications that they used an average of 195 times over the eight-week trial. The mobile application suite was successful in reducing depression and anxiety scores from pre to postintervention, with 37% of participants no longer meeting criteria for depression and 42% no longer meeting criteria for anxiety.

However, there are few randomized controlled trials examining a psychological construct as an outcome. A randomized controlled trial has been conducted with an EMI examined in conjunction with in-person group therapy. In this study ($N = 34$; Newman et al., 2014), the cognitive-behavioral therapy EMI adjunct to group therapy appeared to be effective (although not necessarily more effective than the group therapy alone) for those with generalized anxiety disorder. The EMI consisted of three modules, in which the first two weeks were assessment (i.e., “diary”) only without an intervention component. The second module involved an intensive two-day monitoring period in which participants received a notification every waking hour to ask them to identify current anxiety cues in their surroundings. The third module involved receiving motivational and interventional messages (e.g., “Would you like to practice some relaxation technique?”). One randomized controlled trial without face-to-face support exists, albeit the intervention was brief (Kivity & Huppert, 2016). This study examined the effectiveness of a one-week micro-intervention that taught cognitive reappraisal (i.e., changing the way one thinks about a situation) to students with social anxiety. The intervention was short and involved a simple daily morning text message reminder for participants to reappraise their thoughts (versus a condition that was asked to monitor their thoughts). Although

daily average and peak social anxiety did not differ between the reappraisal ($n = 43$) and monitoring ($n = 40$) conditions among students with high social anxiety, those in the reappraisal condition reported lower severity of anxiety symptoms measured at postintervention.

Despite the lack of randomized controlled trials in this area, there appears to be some promise for EMIs in decreasing psychological symptoms given the studies reporting high feasibility, acceptability, and usability (e.g., 87% acceptability and usability, Ben-Zeev et al., 2014; 78% usefulness, Guarino, Acosta, Marsch, Xie, & Aponte-Melendez, 2016). A review (Schueller et al., 2017) of EMI studies that included non-randomized controlled trials discussed the potential for EMIs to improve psychological constructs. According to this review, EMIs had a small-to-medium effect on within-person changes in depression ($g = 0.48$; Versluis, Verkuil, Spinhoven, van der Ploeg, & Brosschot, 2016) and generalized anxiety ($g = 0.47$; Loo Gee, Griffiths, & Gulliver, 2016) with mixed findings for panic disorder and social anxiety, likely due to low study numbers.

Despite the high use of mobile phones among young adults (IDC, 2013), studies have not yet focused on college students. EMIs targeted for college students tend to all focus on substance use behaviors (e.g., Riley, Obermayer, & Jean-Mary, 2008; Riordan, Conner, Flett, & Scarf, 2015; Witkiewitz et al., 2014) rather than on decreasing psychological distress despite the established link between mental health and academic functioning (South et al., 2007). Given research on the effectiveness of a present control and mindfulness intervention in reducing distress among college students (e.g., Nguyen-

Feng et al., 2016), an EMI focusing on increasing present control and teaching mindfulness may be beneficial for this population and perhaps uniquely for students with a history of emotional abuse, who tend to report more distress (e.g., Wright et al., 2009). Given the inverse relationship between present control and avoidant coping (Frazier et al., 2011a), a present control and mindfulness EMI could teach individuals to engage in more proactive coping (e.g., by learning present control skills) as opposed to avoiding dealing with stressors. This may be beneficial for college students, who typically report high levels of stress; for instance, more than half of students report experiencing either “more than average” or “tremendous” levels of stress in the past year (ACHA, 2017) and approximately half of college students have a diagnosable psychological disorder (Blanco et al., 2008; Holmes & Silvestri, 2016).

Present Study

This study is the first randomized controlled trial to examine the feasibility and efficacy of an ecological momentary intervention for reducing psychological distress among at-risk students, specifically those with a history of childhood emotional abuse. This study contributed to the literature in several ways. First, the study assessed the effects of an under-researched form of trauma on daily life, adding to the limited literature on emotional abuse. Second, the study developed and tested an EMI, an innovative psychological intervention that aimed to reduce distress among students with and without a history of emotional abuse and also to improve their academic performance as a result. If EMIs are feasible and effective for at-risk groups and the general student body, college counseling centers can adopt this approach to provide services to more

students. Third, the study employed a randomized controlled design, in contrast to the majority of EMI studies, which are pilot studies or have no control groups (e.g., Inada et al., 2016; for reviews, see e.g., Buchholz et al., 2013; Heron & Smyth, 2010). Fourth, this study involved a three-week follow-up assessment during the final examination period, which is particularly unique given that only 17 of 55 EMI studies in a systematic review conducted any follow up (De Leon et al., 2014). This study additionally contributes to the EMI literature because of its data analysis strategy, as the majority of EMIs use only pre-post assessment designs (for a review, see Heron & Smyth, 2010) that do not maximize the robustness of these micro-longitudinal data.

This study took both a prevention and a promotion approach, which are viewed to be overlapping and complementary in mental health care (WHO, 2002). The approach was preventive in that it was implemented before the end of the semester and finals period, which was anticipated to be a time of maximal distress and stress among college students. Through a preventive approach, the intervention included aims to keep distress levels from elevating as much as they could (i.e., compared to the non-intervention group). The approach was also promotive in that, aside from simply aiming to reduce distress, it aimed to promote skills to increase mental health care and improve individuals' coping capacities through present control and mindfulness. Overall, the present study's aims were to assess the efficacy of the EMI in decreasing distress, increasing present control and mindfulness, and decreasing avoidant coping and rumination. Participants were randomized into groups that either: 1) received the EMI and twice-daily assessments regarding their mood (e.g., depression, anxiety, perceived

stress) and stressors (e.g., interpersonal issues, academic concerns); or 2) completed the assessments only (EMA only). Measures were administered before and after the 14-day intervention as well as at a three-week follow-up.

In line with the aforementioned goals, the hypotheses were the following:

Hypothesis 0. Students with a history of emotional abuse would report more distress at baseline than those without a history of emotional abuse. This was based on the literature indicating that individuals with a history of emotional abuse report greater distress, even compared to those who have experienced other forms of abuse (e.g., sexual victimization, physical abuse; Burns et al., 2009). This hypothesis was included in the dissertation proposal though not in the pre-registration protocol.

Hypothesis 1. The EMI would be more effective than the EMA only condition in reducing distress for the general student population, with small to moderate between-group effect sizes, and larger within-group effect sizes for the EMI condition than the EMA condition. Effect sizes were expected to be small to moderate based on previous between-group effect sizes for the present control intervention ($ds = 0.29-0.44$ at postintervention; Frazier et al., 2015; Hintz et al., 2015; Nguyen-Feng et al., 2015; see Table 1). Additionally, reviews of EMIs and EMAs (Armey, 2012; Beckjord & Shiffman, 2014) have found that EMAs may also lead to behavioral changes, as the act of repeated self-monitoring helps increase awareness of behaviors. The EMA in the present study was intended to control for time and expectancy effects. Within-group effect sizes in the EMI group were expected to be moderate given previous within-group effect sizes with the original present control intervention in university students ($ds = 0.26-0.49$; e.g.,

Nguyen-Feng et al., 2015). Within-group effect sizes in the EMA group were expected to be smaller than those in the EMI group; though effect sizes may be smaller, they may still be statistically significant based on other self-monitoring studies (for a review, see e.g., Arney, 2012).

Hypothesis 1a. The EMI would be as or more effective for students with (versus without) a history of emotional abuse. Because they are at risk for greater distress (e.g., Burns et al., 2010), the EMI may be more effective for them. Specifically, there would be an interaction between emotional abuse history and intervention condition. This hypothesis was also based on previous intervention research that demonstrated that those with a history of interpersonal trauma benefited more from a web-based present control intervention than those without such a history (e.g., Nguyen-Feng et al., 2015).

Hypothesis 2. Increases in present control and mindfulness and decreases in avoidant coping and rumination would mediate the relationship between intervention condition and current distress. Previous research demonstrated that increases in present control served as the mechanism of change between intervention condition and current distress in students (Hintz et al., 2015; Frazier et al., 2015; Nguyen-Feng et al., 2015). Additionally, avoidant coping is highly correlated with present control (Nguyen-Feng et al., 2017a), suggesting the potential for decreases in avoidant coping serving as a mechanism of change as well. Both avoidant coping and rumination are considered forms of maladaptive coping that decrease in treatment studies alongside psychological outcomes such as depression and anxiety (for a review, see e.g., Sloan et al., 2017). Previous research has also demonstrated that a web-based present control intervention

may be more effective for survivors of interpersonal trauma because it decreases rumination (Nguyen-Feng et al., 2015), which is inversely related to mindfulness (e.g., Deyo et al., 2009). Thus, in this proposed mediated moderation, greater present control and mindfulness and less avoidant coping and rumination, would potentially mediate the relations between intervention condition and lowered distress for both the groups with and without a history of emotional abuse.

Hypothesis 3. The EMI would be perceived as feasible, usable, and acceptable among the study sample, given the literature on mobile phone technology use among young adults (e.g., IDC, 2013).

Method

The protocol (e.g., hypotheses, recruitment and randomization, materials, procedure, data analysis plan) of the present study was pre-registered with the Center for Open Science and is available at <https://osf.io/hgfrt>. Any changes to the pre-registered protocol are stated.

Participants

Sample. Participants ($N = 382$) were undergraduate students recruited through psychology courses at a large Midwestern university. Recruitment occurred both offline (e.g., in-class announcements, campus bulletin boards) and online (e.g., via class listservs, online posting). The announcement stated the following requirements: “To be eligible for this study, you need to: 1) be feeling stressed about anything (e.g., school, relationships) and 2) want to learn how to manage stress better.” Participants received extra credit for participation and were told that they were invited to participate in a

research study conducted at the University of Minnesota the purpose of which is to gain a better understanding of how stress may be reduced through daily practices. Students who expressed interest in participating were sent a link to the consent form (see Appendix A) and pretest survey. An online checkbox to acknowledge consent to continue in the study was used. Students were not screened for computer or Internet literacy or access to a smartphone; however, participants were required to have a university Internet username and login to securely access the assessments. According to aggregate user data from Yapp, the mobile application platform that was employed, 76% of participants in the EMI condition and 80% of participants in the EMA condition were Apple users while the remaining participants (24% in EMI; 20% in EMA) were Android users. All assessments were self-reported and administered via Qualtrics, which could be completed either on a web-based or mobile browser. There were no face-to-face components of this study or intervention.

According to GLIMMPSE web-based software (Kreidler et al., 2013), 288 participants were needed for a desired statistical power set of 80%, alpha set at .05, and other parameters considered. Regarding the other parameters, for instance, intervention condition and emotional abuse status (dichotomous based on Bernstein and Fink's [1998] cut points with score ≥ 8) were input as between-participant factors. Distress was input as a response variable. Time was input as a repeated measure with three time points (pre, post, follow-up) with equal spacing between each (3 weeks) and used a Hotelling Lawley Trace approach. Hotelling Lawley Trace was recommended by Kreidler et al. as the most appropriate test for complex between- and within-participant characteristics. The

estimated relative proportion of the four groups (i.e., number of participants with and without a history of emotional abuse in EMI condition; number of participants with and without a history of emotional abuse in EMA condition) were input, assuming that those without a history of emotional abuse would be up to three times as large as the group with a history of emotional abuse. The primary study hypothesis was input as a three-way interaction among intervention, emotional abuse, and time. Expected mean values and standard deviations were obtained from a previous web-based intervention study with a similar study sample to estimate the effect size (Nguyen-Feng et al., 2017b). The base correlation, or correlation between measurements taken one unit apart, was assumed to be approximately $r = .69$ (Nguyen-Feng et al., 2017b). The decay rate, or the rate of decrease in the base correlation over the repeated measures, was estimated to be .03 (Nguyen-Feng et al., 2017b).

Because 10-12% of respondents were anticipated to be “careless responders” (Meade & Craig, 2012), additional participants were included in the power calculations to account for 12% unusable participant data, yielding a recruitment goal of 327 participants who went through the informed consent procedures. Because previous research with this population (Nguyen-Feng et al., 2017b) indicated that approximately 9% of those who expressed interest did not complete the informed consent procedure, the recruitment goal was 360 participants who expressed interest in the study, as indicated through sign-up in their psychology course. Data collection terminated upon completion of the study timeline. See Appendix D for the study timeline.

The majority of the sample identified as female (77%). On average, participants were 21.3 years old ($SD = 4.2$). Regarding year in school, 16% identified as freshmen, 24% identified as sophomores, 33% identified as juniors, and 25% identified as seniors, with 11% of all participants identifying as international students. Most (70%) participants identified as European American/White, followed by Asian/Asian American (19%). African American/Black and Hispanic/Latinx each represented 3% of the sample. Other (e.g., Native American, Middle Eastern/Arab American) and mixed racial/ethnic groups each represented 1% or less of the sample. Most participants (58%) reported having a part-time job, with 7% reporting that they worked full-time and 36% reporting that they did not have a job. Regarding current romantic relationship status, participants were primarily single (47%) with some in committed relationships (5% cohabitating and 28% not cohabitating), some dating (15%), and a small number of students being married or divorced (4% total). The majority of participants identified as heterosexual/straight (88%), followed by pansexual/bisexual (6%), gay/lesbian/queer (5%), and other (1%). The university's institutional review board approved the protocol for this study. E-CONSORT guidelines were followed to describe elements of the study.

Materials

Please see Appendix B for complete versions of the included measures. Daily measures included abbreviated versions of the complete measures. The process of selecting daily measure items is described below, as appropriate. With the exception of the feasibility, usability, and acceptability measure, the measures may not have been validated for online use; however, psychometric properties of online and paper-and-

pencil versions of assessments tend to be similar (see e.g., Vallejo, Jordán, Díaz, Comeche, & Ortega, 2007). Materials are listed in the order that they were presented in the survey, with a description of the intervention first. Primary outcomes of interest are labeled as dependent variables.

Ecological momentary intervention. The intervention was developed by the researchers and was offered to study participants free of charge. The intervention was piloted for one week with 15 undergraduate students in psychology, which represented the larger pool from which participants were drawn. These undergraduate students were recruited by contacting undergraduate psychology research assistants working with counseling psychology faculty members. They completed the initial version of the EMI (Week 2 of the study) and then provided quantitative and qualitative feedback to the research team using the structured Feedback Survey (Guarino et al., 2016). The top three rated visual analog scale (using a 0 to 100 scale) categories related to the EMI's easiness to use (99 out of 100), easiness to understand (96 out of 100), and satisfaction (89 out of 100). The lowest three rated categories related to whether the EMI clarified any misunderstandings (61 out of 100), would be potentially useful if more content were included (69 out of 100), and conveyed new information (73 out of 100). Their feedback along with feedback from graduate students ($n = 4$) and faculty members ($n = 2$) who piloted the EMI were incorporated into the design of the EMI.

The EMI itself was created based on several existing guidelines and reviews in the literature (e.g., Ben-Zeev et al., 2015; Willoughby & Furberg, 2015). See Appendix D for the study timeline. At 9 p.m. on the first day of the study, participants in each

group were sent different videos. Participants in the EMA condition received a psychoeducational video (2 minutes, 44 seconds in length) on how stress affects college students (see e.g., Frazier et al. 2015). This video was adapted from the empirically supported, web-based present control intervention (see e.g., Frazier et al., 2015). To control for expectancy effects, the video also discussed the benefits of self-monitoring. The participants in the EMI condition received a different video (5 minutes, 35 seconds in length) providing brief psychoeducation regarding how stress affects college students and in-depth psychoeducation about the different aspects of the intervention. Specifically, the video provided information on perceived present control, non-reactivity (for a meta-analysis, see e.g., Gu et al., 2015), and the negative effects of avoidant coping (Aldao et al., 2010). Participants in the EMA only received the psychoeducational video described above as well as the daily self-monitoring assessments.

For three semi-alternating days thereafter (i.e., Tuesday, Thursday, Sunday) across two weeks, all participants in the EMI condition (and not the EMA condition) were asked to complete a written exercise in which they examined what was inside and outside of their control adapted from Solie (2013; used in Nguyen-Feng et al., 2017). Additionally, integrating mindfulness/non-reactivity (e.g., Burdick, 2013), the written exercise asked participants to let go of what was outside of their control. See Appendix C for an example of the written exercises. Participants were informed that the written exercises were also accessible to them via the mobile app at any time of the day, if they felt the need to complete them.

At 9 p.m. on day one of the second week of the EMI (i.e., Day 8), those in the EMI group were sent a video (5 minutes, 44 seconds in length) on different aspects of control and benefits of present control (see e.g., Frazier et al., 2015). Otherwise, the EMI was identical to the first week, described above, in that participants received the written exercises on present control for three semi-alternating days thereafter (i.e., Tuesday, Thursday, Sunday). See Appendix C for examples of the intervention.

Per Ben-Zeev et al.'s (2015) recommendations, interactions with participants were short and frequent through simple push notifications. Participants in the EMI condition received one motivational message or reminder delivered via push notification at a random time between 1 p.m. and 6 p.m. daily. The randomization processes to determine timing of motivation messages and reminders in this study were conducted with random number generators on <http://www.random.org>. In a systematic review (Militello, Kelly, & Melnyk, 2012), daily to weekly text messaging interventions that included reminders and tips had significant effects in promoting healthy behavioral changes. See Appendix C for the motivational messaging examples.

These messages were adapted from an empirically-supported, web-based present control intervention that employed motivation interviewing techniques (see e.g., Frazier et al., 2015), from mindfulness-based therapy approaches (see e.g., Burdick, 2013; Harris, 2009), and from encouraging language found in other EMIs employing motivational messaging (e.g., "You can do it!"; Garofalo et al., 2016). Of the 14 messages sent over 14 days, five messages focused on present control (e.g., "Think about the actions you listed on your last present control written exercise. You can do them!"),

five focused on mindfulness (e.g., If you're feeling upset, remember the stoplight metaphor. Red: Stop. Yellow: Observe. Green: Proceed wisely"), and four focused on motivational interviewing (e.g., "Think about what encourages you to handle stress better").

Additional videos, audios, and resources were provided to the participants, and they received reminders to access these resources at a random time between 6 p.m. and 9 p.m. daily. A reminder regarding these resources was also presented upon submitting each assessment survey. The topics of the mindfulness audios (i.e., mindfulness breathing meditation, body scan, awareness of thoughts and feelings) were adapted from a present control and mindfulness web-based intervention delivered to the same population (Nguyen-Feng et al., 2017b) and incorporated the facets of mindfulness (viz., non-reactivity) that were most linked to positive clinical outcomes (e.g., less depression, less anxiety, more quality of life; Quaglia et al., 2016). The scripts of the mindfulness exercises used in the present study are from Pollack, Pedulla, and Siegel (2014). See Appendix C for examples. A trained research assistant was charged with administering the different aspects of the intervention from a Yapp administrator account. Intervention condition was measured as an independent variable between participants, in which there were two levels (EMI, EMA).

Baseline characteristics (pretest). Basic demographic data including age, year in school, international student status, employment status, sex, relationship status, sexual orientation, and race/ethnicity were assessed at pretest.

Distress/Affect (pretest, posttest, follow-up, mornings, evenings). Distress was measured pretest and posttest with the 20-item Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988). Items (e.g., interested, distressed, excited) were rated on a 1 (*very slightly or not at all*) to 5 (*extremely*) scale with regard to how much the respondent experienced a particular mood currently (mornings, evenings) or over the past week (pretest, posttest). Watson et al. provided evidence for the reliability and validity of scores on the PANAS in an undergraduate student sample. An adapted version of the PANAS, the International Positive and Negative Affect Schedule Short Form (I-PANAS-SF; Thompson, 2007) was used for the daily assessments. This adapted version used 10 of the 20 original items. Thompson provided evidence for the reliability and validity of scores on the I-PANAS-SF in an international university student sample. True score reliability (Shrout & Lane, 2012), the proportion of variability due to changes in values over time across individuals, was .83 (morning) and .79 (evening) daily for the I-PANAS-SF Positive Affect subscale. The I-PANAS-SF Negative Affect subscale reliability was .69 for both morning and evening daily measures. At the non-daily time points (pre, post, follow-up), Cronbach's alpha in this sample ranged from .90 to .92 for the PANAS Positive Affect subscale scores and from .85 to .89 for the PANAS Negative Affect subscale scores.

The Depression Anxiety and Stress Scale (DASS-21; Lovibond & Lovibond, 1995) and the Perceived Stress Scale (PSS; Cohen, Kamarck, & Mermelstein, 1983) were included at the pretest and posttest assessments to further assess distress over the past week. DASS-21 is a 21-item measure containing three 7-item scales assessing

depression, anxiety, and stress (e.g. “I couldn’t seem to experience any positive feeling at all”). Items were rated on a 0 (*does not apply*) to 3 (*very much*) scale. Lovibond and Lovibond reported evidence for the reliability and validity of scores on the three subscales in a psychology undergraduate student sample. The PSS has 10 items that measure the perception of stress (e.g. “How often have you felt that you were effectively coping with important changes that were occurring in your life?”). Items were rated on a scale from 0 (*never*) to 4 (*very often*). Cohen et al. reported evidence for reliability and validity of scores in a community sample of adults in the United States. Cronbach’s alphas in this sample ranged from .87 to .91 for the DASS Depression subscale, .77 to .80 for the DASS Anxiety subscale, .83 to .86 for the DASS Stress subscale, and .86 to .88 for PSS. Distress was measured as a dependent variable.

Stressors (pretest, posttest, follow-up, evenings). A recent stressor was assessed at pretest, posttest, and follow-up with a single open-ended item: “Think back to a time in the past two weeks when you experienced something stressful. Briefly describe the situation here.” In addition, daily in the evenings, participants rated how stressful and good their day was (1 = *not at all*; 4 = *very*) and completed a checklist of 10 stressors experienced by college students. The stressors checklist was generated from qualitative coding of participants’ free responses in previous research on stressful events in college students (Baker et al., 2018; Nguyen-Feng et al., 2017a; Nguyen-Feng et al., 2016) and from items adapted from the Daily Inventory of Stressful Events (Almeida, Wethington, & Kessler, 2002). The 10 stressors (including “other”) were: Too much school work (e.g., major assignment or deadline, large workload); preparing for/taking tests, exams, or

quizzes; balancing school and other priorities; preparing for your future/career path (e.g., filling out applications, finding/losing a job, not getting into major); issues at/with current job; receiving lower grade than wanted; financial problems (e.g., rent or bills due, being broke); interpersonal problem (e.g., with prior/current romantic partner(s), roommate, family member); health-related issue of self or family member; and an “other” option for participants to write in another stressor, if applicable. Participants were asked to select which stressors (yes or no), if any, they had experienced in the last 24 hours on the daily surveys.

Well-being (evenings, if no stressor reported). If participants did not report experiencing a stressor, their well-being was assessed in the evenings with the 21-item Pemberton Happiness Index (PHI; Hervás & Vázquez, 2013). The first section of the PHI consists of 11 questions regarding Remembered Well-being (in the general, hedonic, eudaimonic, and social domains) rated on a 0 (*totally disagree*) to 10 (*totally agree*) scale. An example item is “I think I can be myself on the important things.” The second section of the PHI consists of 10 dichotomous (yes/no) questions regarding experienced well-being, which was defined as positive and negative “emotional events” (i.e., events that elicited emotions that many would experience on a given day across cultures) that recently occurred (e.g., “I gave myself a treat”). Additionally, a follow-up question was included: “What’s the best thing that happened to you today? It can be something on the checklist above or something else. Briefly describe the situation here.” This question was included so that all participants, regardless of whether they did or did not list a stressor, were asked to answer a short-answer question. Hervás and Vázquez provided

evidence for internal consistency, convergent validity, and incremental validity in an international community sample encompassing secondary school and college-aged adults. Cronbach's alpha for the PHI (combined well-being index) was .73 across days. This scale was not used in the present analyses; the PHI was included for participants who did not list a daily stressor, as the PHI was intended to be comparable in completion time to the scales for those who did list a daily stressor.

Problem severity (pretest, posttest, follow-up, evenings if stressor reported).

If participants reported experiencing a stressor, severity of the stressor was assessed at pretest, posttest, follow-up, and in the evenings with the one item question adapted from the Top Problems measure (Weisz et al., 2011). Daily, after asking participants to identify the stressor that bothered them the most that day, the measure asked: "How much did it bother you?" and asked participants to rate the severity of the problem from a 0 (*not at all*) to 10 (*very, very much*) scale. At pretest, posttest, and follow-up, additional questions asked which one of the listed problems is the biggest right now, which one of the listed problems is giving the participant the most trouble right now, and which one of the listed problems is the most important to work on in the stress management program. At pretest, posttest, and follow-up, the measure asked: "How big a problem is this for you?" and asked participants to rate the severity of the problem from a 0 (*not at all*) to 10 (*very, very much*) scale. Weisz et al. demonstrated validity and reliability of scores on their measure in a sample of outpatient youth.

Coping (pretest, posttest, follow-up, evenings if stressor reported). Five facets

of coping were measured at pretest and posttest with the 40-item COPE Revised (R-

COPE; Zuckerman & Gagne, 2003). The R-COPE comprises five subscales and 16 sub-subscales assessing self-punishment (sub-subscales: self-blame, self-focused rumination), self-help (sub-subscales: expressing emotion, emotional support seeking, instrumental support seeking), approach (sub-subscales: active coping, planning, suppression of competing activities), accommodation (sub-subscales: maintaining optimism, acceptance, positive reframing, replacement), and avoidance (sub-subscales: denial, behavioral disengagement, mental disengagement, other-blame). Dispositional coping was assessed at pretest, posttest, and follow-up, in which participants rated items on a 1 (*I don't do this at all*) to a 4 (*I do this a lot*) scale with regard to what they generally do and feel when experiencing stressors. Only self-focused rumination and avoidant coping were used in the present analyses.

Daily, participants rated items on a 1 (*I didn't do this at all*) to a 4 (*I did this a lot*) scale with regard to what they did when experiencing a specific recent stressor that they described as bothering them the most (e.g., “I just thought about my problem constantly”). All four self-focused rumination and four support seeking items were assessed daily in the evenings; all items on these subscales were used to assess rumination and support seeking, as individual constructs. These constructs were uniquely important because rumination and lack of social support are more strongly related to mental health outcomes than other constructs (for a review, see e.g., Aldao et al., 2010; Brewin, Andrews, & Valentine, 2000), though social support was not the focus of the intervention or the present study. The highest loading item of each of the 16 additional sub-subscales (e.g., self-blame) was also included as daily evening measures. Thus, 21

items were included in the daily measure with each subscale comprising three to four items (except for the subscales comprising self-focused rumination and emotional support seeking, which had five items each because all of the self-focused rumination and emotional support seeking items were included in their respective subscales). Zuckerman and Gagne provided evidence for the reliability and validity of R-COPE subscale scores in three different undergraduate student samples. True score reliability in this sample was .86 daily for the self-punishment subscale (5 items), .91 daily for the self-help subscale (4 items), .75 daily for the approach subscale (3 items), .69 daily for the accommodation subscale (4 items), and .55 daily for the avoidance subscale (4 items). Regarding the sub-subscales, true score reliability in this sample was .89 daily for self-focused rumination (4 items) and .91 daily for emotional support seeking (3 items). A minimum of three items was chosen per subscale, following recommendations to increase reliability of daily construct measures (Shrout & Lane, 2012). At the non-daily time points, Cronbach's alpha in this sample ranged from .87 to .91 for the self-punishment subscale, .93 to .95 for the self-help subscale, .87 to .93 for the approach subscale, .89 to .91 for the accommodation subscale, .78 to .86 for the avoidance subscale, and .92 to .94 for the self-focused rumination sub-subscale. Coping was measured as a third variable acting as a proposed mediator.

In addition to the R-COPE, participants were asked how many times they accessed the mobile application or used its listed resources in the past 24 hours. The total number of times that the mobile application and its specific pages were accessed was

downloaded from the Yapp website; this sum was divided by the number of participants to calculate the average number of mobile application page views per participant.

Present control (pretest, posttest, follow-up, evenings if stressor reported).

Present control was measured at pretest, posttest, and follow-up with the eight-item present control subscale of the Perceived Control over Stressful Events Scale (PCOSES; Frazier et al., 2011a). Participants rated items on a 1 (*strongly disagree*) to 4 (*strongly agree*) scale with regard to how they felt about their previously described stressful event (e.g., “I have control over how I think about stressful events”). Daily evening measures consisted of four items: the two items used in a previous daily diary study (Baker et al., 2018; Nguyen-Feng et al., 2017a), one additional item chosen in consultation with the first author of the PCOSES, and one additional item written by the first author of the PCOSES (“I tried to focus on things I had control over”). The additional item written by the first author of the PCOSES was included to assess perceived present control as a focused action. A minimum of three items was chosen for the daily present control measure per recommendations to increase reliability of daily construct measures (Shrout & Lane, 2012). Frazier et al. provided evidence for the reliability and validity of present control subscale scores in college student samples. True score reliability in this sample was .79 for the daily measures and .77 to .82 for the non-daily measures. Present control was measured as a third variable acting as a proposed mediator.

Mindfulness (pretest, posttest, follow-up, evenings if stressor reported).

Mindfulness was measured at pretest, posttest, and follow-up with the seven-item non-reactivity subscale of the Five Facet Mindfulness Questionnaire (FFMQ; Baer, Smith,

Hopkins, Krietemeyer, & Toney, 2006). Participants rated items on a 1 (*never or very rarely true*) to 5 (*very often or always true*) scale with regard to how each statement described them (e.g., “I perceive my feelings and emotions without having to react to them”). Because the items load onto the subscale similarly (range of factor loadings = .05), daily evening measures consisted of three items selected from the non-reactivity subscale via a focus group discussion consisting of 10 pilot study participants. This subscale was chosen based on literature that demonstrated differences in non-reactivity (vs. the other mindfulness facets) among those with an emotional abuse history compared to other forms of trauma (Wang et al., 2013). Additionally, non-reactivity was the facet of mindfulness with the highest relation with positive mental health outcomes according to a meta-analysis (Quaglia et al., 2016). A prior present control intervention study also defined mindfulness in terms of the non-reactivity subscale (Nguyen-Feng et al., 2017b). True score reliability in this sample was .72 for the daily measures and .84 to .90 for the non-daily measures. Baer et al. provided evidence for strong psychometric properties of scores on their measure in various samples of undergraduate psychology students.

History of emotional abuse and trauma (pretest). The five-item emotional abuse subscale from the Childhood Trauma Questionnaire-Short Form (CTQ-SF; Bernstein et al., 2003) was included at pretest to assess emotional abuse (e.g., “I felt like someone in my family hated me”). Items were rated on a 1 (*never true*) to 5 (*very often true*) scale. To diversify the trauma questions so that emotional abuse did not appear singled out, the complete CTQ-SF was administered along with the Traumatic Life Events Questionnaire (TLEQ; Kubany et al., 2000), which assesses exposure to 23

potentially traumatic events. Emotional abuse was measured as a dichotomous variable based on Bernstein and Fink's (1998) cut points with score ≥ 8 indicating emotional abuse. Bernstein et al. reported information on the test-retest reliability and convergent, discriminant, and construct validity of scores on the CTQ-SF across four diverse populations including a psychology undergraduate student sample. Kubany et al. reported information on the validity and reliability of TLEQ scores. Cronbach's alpha in this sample was .87 for the emotional abuse subscale. Regarding the other subscales, Cronbach's alpha for the CTQ subscales in this sample was .91 for childhood sexual abuse, .84 for physical abuse, .62 for physical neglect, and .90 for emotional neglect. Regarding sexual victimization, the CTQ differs from the TLEQ in that the CTQ focuses on childhood sexual victimization while the TLEQ assesses child (including peer), adolescent and adult sexual victimization. History of emotional abuse and the other forms of interpersonal trauma were measured as third variables acting as moderators.

Feasibility, usability, acceptability, and expectancy (after first video for expectancy only; posttest and follow-up for select measures described below). A measure of expectancy was adapted from Borkovec and Nau (1972) and administered after the first video and at posttest. The survey employed three visual analog scales. Items were rated on a 0 (*not at all*) to 100 (*a great deal*). EMI and EMA participants were asked to rate how logical the treatment seemed, how successful they thought the treatment might be, and how confident they were in recommending the treatment to a friend. Questions were rephrased in the past tense for the posttest and follow-up surveys. Additionally, there were expectancy, goal-setting questions (adapted from Turner-Stokes,

2009) administered after the first video on the participants' main problem that they would like to address, what they hoped to achieve from the program, and another visual analog scale rating question of how important the problem was to them. Items were adapted for the mobile intervention, as opposed to goal setting in other contexts (e.g., rehabilitation; Turner-Stokes, 2009).

A structured Feedback Survey (Guarino et al., 2016) was administered at posttest to assess acceptability of the intervention. The survey consists of 11 visual analog scales. Items were rated on a 0 (*not at all*) to 100 (*a great deal*) scale. Six items were asked of both the EMI and EMA participants regarding how much they thought their assigned intervention: 1) was interesting; 2) was useful; 3) conveyed new information; 4) clarified any misunderstandings; 5) was easy to understand; 6) was satisfactory. Five items asked the EMI participants to rate the intervention in terms of its: 1) ease of use; 2) likability; 3) potential usefulness if more content were included; 4) helpfulness in reducing distress; 5) helpfulness in increasing coping skills. In addition, three open-ended items at posttest asked participants for: 1) their general comments on the EMI; 2) suggestions for improvement; 3) additional content areas for future expansions of the application.

Previous feedback surveys on the present control intervention (e.g., Hintz et al., 2015) were administered at posttest and follow-up to assess acceptability of the intervention. These items were adapted to include items specific to the present study (e.g., asking about the helpfulness of motivational messages). At posttest, these questions asked participants how helpful (1 = *not helpful*; 5 = *very helpful*) they found these parts: Videos from Dr. Patricia Frazier, the written exercises, the motivational

messages, the reminders, and the mobile application. Additionally, there was one open-ended question asking participants to list the particular areas that they found unhelpful at posttest. At follow-up, these questions asked about whether participants remembered the aforementioned specific parts of the program (1 = *I don't remember this part at all*; 5 = *I can remember a lot of this part*).

Feasibility and usability were measured by aggregate usage rates from Yapp as well as by survey completion rates. Feasibility, usability, acceptability, and expectancy were measured as dependent variables.

Academic measures. The academic functioning measure was end-of-semester and cumulative grade point averages. These items were pulled from the participants' academic record, as indicated on the consent form. Though the pre-registered protocol indicated that American College Testing scores, Scholastic Assessment Test scores, and high school rank would be included, this information could not be pulled from the participants' academic record. The consent form that was previously used was later deemed not to be sufficient to obtain these parts of the student record.

Additional Materials

Participants also completed the following measures, although they were not included in any analyses. These variables were included to address potential future research questions.

Academic self-efficacy and expectations (pretest, posttest, follow-up).

Academic self-efficacy and expectations were measured at pretest and posttest with an adapted version of the academic self-efficacy subscale of the Motivated Strategies for

Learning Questionnaire (Pintrich, Smith, Garcia, & Mckeachie, 1993). The questions were modified to ask about all courses in the current semester instead of in one course. Pintrich et al. reported reliability and validity for scores on their scale in a Midwestern college student sample.

Neuroticism (pretest, posttest, follow-up). Neuroticism was measured at pretest and posttest with the eight-item neuroticism subscale of the Big Five Inventory (BFI; John & Srivastava, 1999). Items were rated on 1 (*disagree strongly*) to 5 (*agree strongly*) scale with regard to how well certain characteristics (i.e., is relaxed, handles stress well [reverse coded]; gets nervous easily) applied to the participant. The full BFI was also included, which includes the extraversion, agreeableness, conscientiousness, and openness subscales. John and Srivastava reported validity and reliability for scores on their scale in various international and national samples, including one of college-aged men and women.

Sleep (pretest, posttest, follow-up, mornings, evenings). Sleep was assessed at pretest and posttest with an adapted version of the Pittsburg Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) and one item adapted from the Morningness-Eveningness Questionnaire (Horne & Östberg, 1975) to assess whether the participant was a morning or evening person. The PSQI used in the present study excluded two items pertaining to participants' bed partner or roommate, which are not needed to calculate a global PSQI score. The PSQI assesses sleep in the following domains: Subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Daily in the

morning, sleep was assessed with six items adapted from the PSQI and one item adapted from the cognitive-behavioral insomnia therapy (CBT-I) sleep log (Edinger, 2016). The PSQI sleep log questions assessed how long participants slept (i.e., time to sleep and final awakening time), whether they fell asleep within 30 minutes, whether they woke up in the middle of the night or early morning, and how they would rate their quality of sleep overall (1 = *very good*; 4 = *very bad*). The question adapted from the CBT-I sleep log assessed how rested participants felt when they awoke (1 = *not at all rested*; 5 = *well rested*). Daily in the evenings, daytime sleep was assessed with one item adapted from the Pittsburgh Sleep Diary (Monk et al., 1994): “How many naps did you take today? If you took a nap today, about when did your longest nap start and end?” Additionally, the measurement time frame was changed from the original measure (past month) to refer to the previous evening.

Procedure

The study involved several steps (see Appendix D). First, all participants ($N = 382$) completed an online pretest survey containing full versions of the study measures (e.g., coping, perceived control, distress). Participants also verified that they read a mini training manual that provided a step-by-step guide on how to download and use the mobile phone application (i.e., Yapp) during the course of the study. The verification occurred with the participant selecting a link that was accessible at the end of the training manual. With the exception of updated images, the training manual was adapted from the manual employed in a previous daily diary study (Baker et al., 2018; Nguyen-Feng et al., 2017a). Upon completion of the pretest survey, participants were randomly assigned by

the research team in a 1:1 ratio to either the EMI ($n = 191$) or the EMA (i.e., assessment-only; $n = 191$) comparison condition. Randomization for this process was conducted by a member of the research team using the RAND function on Excel. Those who completed the pretest comprised the intent-to-treat sample. This study was single blinded, in which participants were not explicitly told if they received the intervention (EMI) or comparison (EMA) condition.

Second, all participants completed 14 days of twice-daily, brief online surveys consisting of several measures including a stressor checklist and shortened versions of the study measures relevant to this study (e.g., coping, perceived control, anxiety, depression) and daily constructs of interest (e.g., sleep quality, stressor severity). Please see the Materials section for information regarding when each measure was administered (i.e., morning or evening). At 9 a.m. each morning and 9 p.m. each evening, participants received a push notification via Yapp and/or via email providing a link to complete a survey regarding their daily and current experiences. Participants were given four hours to complete each survey. Participants in the EMI condition also completed the intervention over the course of the 14 days (see above for intervention details). This time period was partly chosen due to research suggesting that approximately 18 days is the minimum amount of time to make habitual change (for a review, see Lally & Gardner, 2013). In addition, this time period exceeds the recommended period of “at least one week” to assess daily fluctuations in activity (Harari et al., 2016) and is not a “long” intervention (≥ 9 weeks), which have been demonstrated to have non-significant within-group effects (for a review, see Heber et al., 2017).

Finally, all participants completed a posttest survey containing full versions of the study measures in addition to a feedback survey assessing feasibility, and usability. The pretest survey was completed up to three weeks prior to the daily surveys and the posttest survey was completed within the week following completion of the daily surveys. EMI data were gathered during March to April 2017 with a follow-up posttest assessment during the finals period, approximately three weeks after completion of the intervention and first posttest survey. The study was not stopped, altered, or restarted due to technological or personnel issues that hindered the study and intervention administration timeline from being met.

Data Analysis Plan

The analyses for each hypothesized outcome were as follows:

Hypothesis 0. Students with a history of emotional abuse will report more distress (DASS-21, PSS, PANAS) at baseline than those without a history of emotional abuse. Emotional abuse was calculated as a dichotomous measure (i.e., yes/no regarding reporting a history of emotional abuse). Differences in baseline distress by emotional abuse status were examined with independent samples *t*-tests. Relevant variables included in the analysis were emotional abuse history status (the independent variable) and the measures of distress (DASS-21, PSS, PANAS; the dependent variables), which served as the main outcomes. DASS-21 subscales (Depression, Anxiety, Stress), the PSS, and PANAS subscales (Positive Affect, Negative Affect) were calculated by averaging items within each scale or subscale.

Hypothesis 1. The EMI will be more effective than the EMA only condition in reducing distress (DASS-21, PSS, PANAS) for the general student population, with small to moderate between-group effect sizes. First, conditions were compared at pretest to assess for differences in any other baseline or demographic variables. These differences were assessed with a two-tailed *t*-test for each demographic variable with an alpha level = .05. If there were differences between groups, these differences were controlled for in the analyses by including the variable as a covariate in the model. DASS-21 subscales (Depression, Anxiety, Stress), the PSS, and PANAS subscales (Positive Affect, Negative Affect) were calculated by averaging items within each scale or subscale and then analyzed separately by subscale.

Linear mixed modeling (LMM; viz., covariance pattern modeling) were then used to examine change in DASS-21 and PSS scores from pretest to posttest and follow-up. LMM were used to examine changes in PANAS from pretest, posttest, and follow-up. Daily measures of PANAS were originally planned, but were not included in the final LMMs presented. Results did not change with or without the daily PANAS measures; thus, they were removed for parsimony purposes and due to their lower reliability in comparison to the non-daily PANAS measures (e.g., Negative Affect subscale: Cronbach's alpha = .69 to .82 daily versus .90 to .92 non-daily). Intervention condition served as a between-group variable and time will serve as a within-group variable in the models. LMM offers advantages in measuring dynamic processes over traditional methods such as repeated measures analyses of variance (ANOVAs; Krueger & Tian, 2004; Liu, Rovine, & Molenaar, 2012), particularly in its ability to accommodate missing

data points. Unlike ANOVAs, data do not need to be balanced for LMM. Error structures are assumed to be identical across participants in ANOVAs, though LMMs allow error structures that are not simply compound symmetry. Particularly because EMIs and other longitudinal data collection methods are more prone to missing data than cross-sectional studies (due to the number of time points), LMM is a better method to use with these kinds of data.

Missing data was estimated with restricted maximum likelihood estimation. However, missingness needs to be unrelated to the outcome (i.e., missing at random) (Cnaan, Laird, & Slasor, 1997). MIXED procedure in Statistical Analysis Software (SAS) was used, as it allows for fit testing of a number of covariance structures (Cnaan et al., 1997). Having alternative covariance structures improves the ability to model mean differences, especially in longitudinal studies in which time, not treatment, is a repeated measures factor (Liu et al., 2012). Relevant variables in the analyses included intervention condition (the independent variable) and the measures of distress (DASS-21, PSS, PANAS; the dependent variables), which served as the main outcomes.

Additionally, end-of-semester grade point averages (GPAs) were predicted to be higher among those in the EMI condition than in the EMA condition. An ANCOVA was conducted to assess between-group differences in end-of-semester GPA controlling for cumulative GPA from the previous semester.

Hypothesis 1a. The EMI will be as or more efficacious in reducing distress for those with a history of emotional abuse than for those without a history of emotional abuse. LMMs were used to examine between-group and within-group differences, given

the rationale presented above. Separate analyses were conducted with emotional abuse as a factor in the model with emotional abuse measured dichotomously, as LMMs do not allow for this term to be continuous. Intervention condition and emotional abuse history served as between-group variables and time served as a within-group variable in the model. To assess for the potential moderator effect of emotional abuse history, emotional abuse was included in the model as a covariate to see if there was a differential effect of the intervention as a function of emotional abuse history (three-way interaction of time-by-condition-by-emotional abuse history). Other relevant variables in the analyses included intervention condition (the independent variable) and the measures of distress (DASS-21, PSS, PANAS; the dependent variables). Additionally, an ANCOVA was conducted to assess whether emotional abuse history (moderator) interacted with intervention condition (independent variable) in predicting end-of-semester grade point averages (GPAs), with cumulative GPA from the previous semester as a covariate.

Hypothesis 2. Increases in present control and mindfulness and decreases in avoidant coping and rumination will mediate the relationship between intervention condition and changes in distress. Structural equation modeling (SEM) was used to test the mediation models. The models included indirect paths between the intervention condition variable (EMA vs. EMI) and distress through the mediators as well as direct paths from the intervention condition variable to distress. A latent distress variable was originally planned to consist of indicators that loaded highest onto the latent variable from the following choices: the three subscales of the DASS-21 (Depression, Anxiety, Stress), the PSS, or the positive and negative affect subscales of the PANAS. Distress

was measured at follow-up; however, if there were no between-group differences in intervention conditions at follow-up, the posttest data were planned to be used. Because only two outcomes were ultimately included in the SEM, a latent variable for overall distress was not created to allow for a sufficient number of indicators per construct (e.g., Kenny, Kashy, & Bolger, 1998); rather, item parcels were used as indicators of the outcomes that had significant LMM results. A latent variable for coping consisted of the R-COPE avoidant coping subscales that loaded highly onto the latent variable. Present control, mindfulness, and rumination were observed factors. Present control, mindfulness, avoidant coping, and rumination were included at posttest and follow-up.

Model fit was determined by guidelines from Hooper, Coughlan, and Mullen (2008) and Hu and Bentler (1999), in which fit was assessed using the Root Mean Square Error of Approximation with cut-off at .06, the Standardized Root Mean Square Residual with cut-off at .09, and the Comparative Fit Index with values $\geq .95$ deemed as good fit. This followed Hu and Bentler's two-index presentation strategy, in which fit index combinations (e.g., CFI and SRMR; RMSEA and SRMR) perform better than single-index presentation strategies. If the model did not fit, then modification indices were examined to determine if any paths (e.g., correlated residuals) may be added without changing the theoretical basis of the model. Relevant variables included in the analyses included intervention condition (the independent variable), the measures of distress (DASS-21, PSS, PANAS; the dependent variables), and the proposed mediators (daily present control, mindfulness, coping, rumination). DASS-21 subscales (Depression, Anxiety, Stress), the PSS, PANAS subscales (Positive Affect, Negative Affect), the

PCOSES, the FFMQ non-reactivity subscale, the R-COPE subscales (e.g., self-focused rumination) were calculated by averaging items within each scale or subscale. Distress at follow-up was included in the model, controlling for pretest distress. The proposed mediators were calculated as the proportion of times (average use score) each day averaged over 14 days that the participant used that strategy given that they reported experiencing a stressor.

This data plan followed Kazdin's (2007) suggestions on how to properly conduct mediation analyses. Particularly, measurement of the predictor preceded the mediator, which preceded the outcome variable. Additionally, the proposed mediators were directly manipulated in the intervention, in that the intervention targets teaching present control and mindfulness-based skills.

Hypothesis 3. The EMI will be feasible and perceived as acceptable among the study sample. That is, the EMI was expected to be feasible, usable, and acceptable. Feasibility was measured by study completion rates (e.g., completion of exercises) as well as daily questions assessing whether participants accessed the application tools. Access to the application tools was tracked via mobile application usage. Authors of other EMI studies have deemed their interventions to be feasible with a wide range of adherence, from 77% retention (Depp et al., 2015) to 92% of participants logging onto the program (Guarino et al., 2016). Thus, the study was deemed as feasible if at least 75% of participants completed the intervention.

Acceptability was measured by calculating a mean score from the visual analog scales on the Feedback Survey (Guarino et al., 2016). Guarino et al. suggested that their

EMI was acceptable with mean visual analog scores ranging from 58.5 to 82.3 out of 100 (median = 74.8). Hintz et al. (2015) found that a previous web-based version of this present control intervention was helpful with mean scores on ratings of the helpfulness of various aspects of the intervention ranging from 3.64 to 3.87 out of 5, and Frazier et al. (2015) found a similar intervention to be helpful with mean scores ranging from 3.52 to 3.67 out of 5. Thus, these standards were used to compare acceptability of the EMI tested in the present study. Feasibility and acceptability (e.g., adherence, ratings of intervention helpfulness) differences between the EMI and EMA conditions were assessed with independent-group *t*-tests. For the purposes of this study, qualitative data on feasibility and acceptability were not analyzed.

Results

Preliminary Analyses

SPSS version 24 was used for preliminary data analyses. Following Meade and Craig's (2012) guidelines, individuals were removed from the final dataset if they were labeled a "careless responder." This included giving erroneous responses ($n = 9$) to at least two of the three instructed response questions (e.g., "Answer 2 to this question") on both the pretest and posttest surveys (i.e., at least four incorrect instructed response questions, two at each time point) or affirmatively stating ($n = 13$) that the researchers should not use their data ("We know that sometimes people fill out surveys carelessly or randomly. If you did that, we want to know so that we do not use your data. You will still receive extra credit no matter how you answer: a) Use my data. I put thought into my answers; b) Do not use my data. I did not care when I filled out my survey(s)"). Two

participants met both criteria for careless responding; thus, 20 (7%) unique participants were deemed as careless responders, in which 12 were from the EMI condition and 8 were from EMA condition.

Individual responses were excluded according to data-based outlier criteria, which did not involve special administration of items. Specifically, scores were considered within a normal distribution if they followed Kim's (2013) guidelines for sample sizes greater than 300 (i.e., skewness < 2 ; kurtosis $< |7|$). (The pre-registered protocol only included Kim's guidelines for sample sizes $50 < n < 300$, which was deemed no longer appropriate given the final sample size). Based on these criteria, no variables met the criteria for non-normality. Thus, there were no detected outliers that required visual inspection of their respective histogram for adequate normality. The total sample size removing careless responders consisted of 362 participants. Of these participants, 88% ($N = 320$) completed the posttest and 91% ($N = 330$) completed the follow-up survey. On average, participants completed 23 out of 28 (82%) daily surveys across the 14 days (morning and evening). Completion rates did not significantly differ by condition. See Figure 1 for complete information about participant attrition.

Individual responses were also excluded based on response times. Specifically, diaries completed in the fastest 2.5% response times were removed, following daily diary data cleaning guidelines (McCabe, Mack, & Fleeson, 2012). Four to seven individual responses were excluded at each diary time point. Individuals ($n = 4$) were also removed from relevant analyses if they did not answer all questions on the emotional abuse measure because it would be inaccurate to categorize such individuals as either reporting

or not reporting emotional abuse. Participants were not excluded based on any demographic criteria or any other criteria not listed above.

Table 2 shows the means and standard deviations for variables of interest by condition. The EMI and EMA groups did not significantly differ at the $p < .05$ level on any of the demographic variables or any of the outcome or mediator variables at baseline. Table 3 shows the means and standard deviation for variables of interest by condition by emotional abuse history. The means in this sample were similar to those in other intervention studies (e.g., Nguyen-Feng et al., 2015; Nguyen-Feng et al., 2016) conducted at the same university with a few exceptions. Independent t -tests comparing this sample to another intervention study employing mindfulness exercises (Nguyen-Feng et al., 2017b) demonstrated that this sample reported fewer symptoms across all primary outcome measures at baseline (i.e., depression, anxiety, stress symptoms, perceived stress). Otherwise, means were similar to the other intervention studies. Independent t -tests comparing this sample to a combined dataset of previous present control intervention studies (i.e., Nguyen-Feng et al., 2015; Nguyen-Feng et al., 2016; Nguyen-Feng et al., 2017b) demonstrated that means were similar with the exception that the present sample reported fewer stress symptoms than in the combined dataset, $t(1276) = 5.75, p < .001, d = 0.32$.

Table 4 shows the bivariate correlations between measures at pretest for all participants. Across participants at baseline, all proposed mediators were significantly correlated with outcomes in the hypothesized direction with small to moderate effect sizes, $|r|s = .10-.54$.

At pretest, 31% of the sample reported a history of at least low severity of childhood emotional abuse, following cut points from Bernstein et al. (2003). The prevalence of emotional abuse was comparable to that found in a similar college student sample (e.g., 27%; Nguyen-Feng et al., 2017a). Regarding other types of trauma measured by the CTQ, 37% reported a history of childhood emotional neglect, 30% reported a history of childhood physical neglect, 13% reported a history of childhood sexual abuse, and 10% reported a history of childhood physical abuse, following Bernstein and Fink's criteria for at least low severity. These prevalence rates were comparable to those found in a similar college student sample (e.g., 31% emotional neglect, 25% physical neglect, 10% sexual abuse, 14% physical abuse; Baker et al., 2018). On the TLEQ, 32% of participants reported a history of sexual victimization, defined as experiencing unwanted sexual attention, child molestation by a peer, child molestation by an adult, adolescent sexual abuse, and adult sexual abuse. The prevalence of sexual victimization was comparable to that found in a similar college student sample (e.g., 34%; Nguyen-Feng et al., 2017a).

Hypothesis 0: Students with a history of emotional abuse will report more distress at baseline than those without a history of emotional abuse

See Table 5 for means, standard deviations, and correlations of outcome variables by emotional abuse history. Students with a history of emotional abuse reported more distress across all outcome measures (DASS-21, PSS, PANAS) at baseline than those without a history of emotional abuse. Specifically, those who had experienced emotional abuse reported more depression, $t(356) = 6.11, p < .001, d = 0.67$), more anxiety ($t(356)$

= 4.07, $p < .001$, $d = 0.45$), more stress symptoms ($t(356) = 5.85$, $p < .001$, $d = 0.65$), more perceived stress ($t(356) = 4.72$, $p < .001$, $d = 0.54$), less positive affect ($t(356) = -3.10$, $p < .001$, $d = -0.35$), and more negative affect ($t(356) = 4.99$, $p < .001$, $d = 0.56$) than those without such a history at baseline. Effect sizes were small to moderate.

In addition, independent samples t -tests were conducted to examine baseline differences in the proposed mediators (present control, mindfulness, avoidant coping, and rumination). Students with a history of emotional abuse reported less present control ($t(353) = -5.13$, $p < .001$, $d = -0.58$), less mindfulness ($t(356) = -2.06$, $p = .04$, $d = -0.23$), more avoidant coping ($t(355) = 2.68$, $p = .01$, $d = 0.53$), and more rumination ($t(356) = 4.53$, $p < .001$, $d = 0.55$) than those without such a history. Effects sizes were small to moderate.

Hypothesis 1: The EMI would be more effective than the EMA only condition in reducing distress for the general student population, with small to moderate between-group effect sizes, and larger within-group effect sizes for the EMI condition than the EMA condition

See Table 6 for contrast coefficients from the LMMs. LMMs were used to examine changes from pretest, posttest, and follow-up for DASS-21, PSS, and PANAS scores. There were significant effects of time across conditions for perceived stress ($F(2, 360) = 4.13$, $p = .02$), positive affect ($F(2, 360) = 11.23$, $p < .001$), and negative affect ($F(2, 360) = 10.60$, $p < .001$), though changes in negative affect were opposite of the hypothesized direction. There were no significant condition-by-time interaction effects. This suggested that, on average, participants decreased in perceived stress and increased

in both positive and negative affect over time regardless of condition (EMI vs. EMA). Examining specific effects by condition, there was a significant decrease in anxiety for those in the EMA ($\beta = -.08, p = .03$) and a significant increase in positive affect for those in both the EMI ($\beta = .21, p < .001$) and the EMA ($\beta = .14, p = .01$) conditions.

Additionally, an ANCOVA suggested no between-condition differences in end-of-semester GPA controlling for cumulative GPA from the previous semester, $F(1, 358) = .13, p = .72$. End-of-semester GPA and cumulative GPA were highly correlated, $r = .83$.

See Table 7 and Table 8 for within-group and between-group effect sizes, respectively. Within-group effect sizes accounted for the correlation between measures across time and were calculated according to this formula: $d = \frac{M1-M2}{SD_{pooled}/\sqrt{1-r}}$. The within-group effect sizes for the EMI and EMA conditions from pretest to follow-up were mostly negligible to small, though all in the hypothesized direction with the exception of increases in negative affect (for both EMI and EMA) and a negligible increase in DASS Anxiety for the EMI condition (within-group $d = 0.06$). Within-group effect sizes were small-moderate for positive affect for both the EMI (within-group $d = 0.42$) and EMA (within-group $d = 0.30$) conditions. Between-group effect sizes comparing changes in the EMI versus the EMA were negligible with the exception of a small difference favoring the EMA over the EMI in reducing DASS Anxiety scores (between-group $d = 0.34$).

Hypothesis 1a: The EMI condition will be as or more efficacious in reducing distress than the EMA condition, with a potential moderator effect of emotional abuse history

Table 6 contains contrast coefficients from the LMMs. To assess for the potential moderator effect of emotional abuse history, emotional abuse was included in the LMMs as a covariate to see if there is a differential effect of the intervention as a function of emotional abuse history. With emotional abuse history in the model, there were still no significant condition-by-time interaction effects. However, the trauma-by-condition-by-time interaction effect was significant for DASS Depression ($F(2, 354) = 7.95, p < .001$) and approached conventions of statistical significance for DASS Stress ($F(2, 354) = 2.36, p = .09$). Contrasts examining the differences of least squares means indicated that those with a history of emotional abuse in the EMI condition decreased the most in depression ($\beta = -.26, p < .001$) and stress symptoms ($\beta = -.18, p = .02$). There were also significant contrasts in the hypothesized direction for changes in positive affect ($\beta = .21, p = .03$) from pretest to follow-up among those with a history of emotional abuse in the EMI condition. For those with a history of emotional abuse in the EMA condition, there were no significant contrasts for the outcomes from pretest to follow-up. Among those without a history of emotional abuse, the only significant contrast in the hypothesized direction was for positive affect ($\beta = .22, p < .001$) in the EMI while depression ($\beta = -.09, p = .08$) and anxiety ($\beta = -.08, p = .06$) in the EMA condition approached conventional standards of significance. There was a significant increase in negative affect ($\beta = .13, p = .04$) from pretest to follow-up for those without a history of emotional abuse in the EMI.

Regarding the academic measure, an ANCOVA suggested no between-condition differences in end-of-semester GPA controlling for cumulative GPA from the previous semester when emotional abuse history was included in the model, $F(1, 357) = .70, p = .40$.

See Table 7 for within-group effect sizes. Cohen's d s were calculated for four groups: 1) EMI and history of emotional abuse; 2) EMA and history of emotional abuse; 3) EMI and no history of emotional abuse; and 4) EMA and no history of emotional abuse. Among those with an emotional abuse history in the EMI condition, the within-group effect sizes from pretest to follow-up were mostly small to moderate (within-group $|d|$ s = 0.25-0.53), with the exception of negligible decreases in anxiety (within-group $d = -0.04$) and negative affect (within-group $d = -0.01$). Effect sizes from pretest to follow-up tended to be larger and in the hypothesized direction for those with a history of emotional abuse in the EMI condition versus those with a history of emotional abuse in the EMA condition. For instance, participants with a history of emotional abuse in the EMA condition increased in depression (within-group $d = 0.09$) and negative affect (within-group $d = 0.28$) over time, although these outcomes were not significant in the linear mixed model.

See Table 8 for between-group effect sizes. Between-group effect sizes comparing EMI vs. EMA among those with or without an emotional abuse history indicated negligible to moderate differences. Of the moderate effect sizes (e.g., DASS Depression, DASS Stress), the EMI condition was most effective among those with an emotional abuse history and the EMA condition was most favorable among those without

an emotional abuse history. Specifically, for those with a history of emotional abuse, the EMI was more effective than the EMA with moderate effect sizes for DASS Depression (between-group $d = 0.62$) and DASS Stress (between-group $d = 0.41$). Likewise, the EMI was more effective for those with a history of emotional abuse than for those without a history of emotional abuse with moderate-large effect sizes for DASS Depression (between-group $d = 0.76$) and DASS Stress (between-group $d = 0.54$). For those without a history of emotional abuse, the EMA was more effective than the EMI with small-moderate effect sizes for DASS Depression (between-group $d = -0.66$), DASS Anxiety (between-group $d = -0.44$), and DASS Stress (between-group $d = -0.26$). See Figures 2-7 for graphs of the linear mixed model least square means estimates for the outcome variables. Because positive and negative affect were the only outcome variables that had daily measures and because results did not change with daily measures in the linear mixed model, results are presented without these daily measures in the respective models for simplicity. In general, the graphs demonstrated a consistent pattern in which there was more change (e.g., steeper slopes) from posttest to follow-up than from pretest to posttest. Additionally, the graphs tended to show the steepest changes in the EMI-Emotional Abuse and EMA-No Emotional Abuse groups.

Because emotional abuse moderated the relationship between intervention condition and distress outcomes for only two outcomes (DASS Depression, DASS Stress), other interpersonal trauma variables were also assessed as potential moderators, per the pre-registered protocol. Building on prior research examining relations between emotional abuse and sexual victimization (e.g., Nguyen-Feng et al., 2017a), CTQ

childhood sexual abuse (Table 9) and CTQ/TLEQ sexual victimization (Table 10) were explored. Because of similarities between emotional abuse and emotional neglect, CTQ emotional neglect (Table 11) was also explored. Previous studies have demonstrated that sexual victimization is associated with more current distress than are other forms of interpersonal traumas, such as sudden bereavement (e.g., Frazier, Nguyen-Feng, Fulco, Anders, & Shallcross, 2017). In these exploratory models in the present study, these forms of interpersonal trauma variables were included in separate LMMs as covariates to see if there was a differential effect of the intervention as a function of trauma history.

Regarding childhood sexual abuse, the trauma-by-condition-by-time interaction effects were significant for DASS Depression ($F(2, 356) = 4.83, p = .01$) and DASS Anxiety ($F(2, 356) = 3.59, p = .03$) and marginally significant for PANAS Negative Affect ($F(2, 356) = 2.74, p = .07$). Contrasts examining the differences of least squares means between pretest and follow-up indicated that, specifically, the EMI was more helpful for those with a childhood sexual abuse history (e.g., decreased depression, $\beta = -.33, p < .01$) and less helpful for those without a childhood sexual abuse history (e.g., increased anxiety, $\beta = .16, p < .05$) while the EMA was more effective for those without such a history (e.g., decreased anxiety, $\beta = -.11, p < .01$). The standardized betas for those with a child sexual abuse history in the EMI condition were mostly statistically significant in the hypothesized direction while the standardized betas for those without a child sexual abuse history in the EMI condition were mostly non-significant; additionally, all of the standardized betas for those with a history of child sexual abuse in the EMA

condition were non-significant, indicating no significant changes from pretest to follow-up.

Furthermore, when examining sexual victimization (i.e., child, peer, adolescent, or adult sexual victimization), the trauma-by-condition-by-time interaction effects were significant for DASS Depression ($F(2, 356) = 6.31, p < .01$), DASS Stress ($F(2, 356) = 3.57, p = .03$), and PANAS Negative Affect ($F(2, 356) = 3.23, p = .04$). Contrasts indicated that, specifically, the EMI was more effective for those with a sexual victimization history (i.e., decreased depression, $\beta = -.26, p < .01$; decreased stress, $\beta = -.25, p = .02$) than for those without (i.e., increased negative affect, $\beta = .33, p = .02$) while the EMA was more effective for those without such a history (i.e., decreased depression, $\beta = -.09, p < .05$) than for those who had experienced sexual victimization (i.e., increased negative affect, $\beta = .27, p = .03$).

Lastly, childhood emotional neglect had significant trauma-by-condition-by-time interaction effects for DASS Depression ($F(2, 356) = 9.10, p < .001$) and DASS Anxiety ($F(2, 356) = 4.09, p = .02$) and marginally significant three-way interaction effects for DASS Stress ($F(2, 356) = 2.57, p = .08$) and perceived stress ($F(2, 356) = 2.82, p = .06$). Of the pretest to follow-up contrasts, there was a pattern for the EMA to be more effective among those without an emotional neglect history (i.e., decreased depression, $\beta = -.14, p = .01$; decreased anxiety, $\beta = -.10, p = .03$) than for those with such a history. Similar to the analyses with emotional abuse, there was a general pattern that the EMI was more effective for those with a trauma history (specifically in that the EMI was not

effective for those without a history of emotional neglect) and the EMA was more effective for those without a trauma history in select outcome variables.

Hypothesis 2: Increases in present control and mindfulness and decreases in avoidant coping and rumination will mediate the relationship between intervention condition and current distress

SEM was used to test the mediation models. See Figures 7 and 8 for the SEM models. Each part of the model will be explored in turn below, from the predictor, to the proposed mediators, to the outcomes. Though the pre-registered protocol stated that the interaction of emotional abuse and intervention condition would be included as a predictor, a multi-group SEM was conducted with emotional abuse as the grouping variable and intervention condition as the predictor. Because the intention of the mediation models was to examine mechanisms of change, which relates to assessing mediators of intervention effectiveness, models only with intervention condition as the predictor were not considered. Per follow-up analyses listed in the pre-registered protocol, emotional abuse was thus included in the mediation models.

With a multi-group SEM, paths between intervention condition and the proposed mediators and outcomes could be specifically assessed for those with and without a history of emotional abuse. Because of lower reliability of scores on the daily measures compared to the non-daily measures (see Method—Measures subsection), posttest measures were used to assess the proposed mediators (and thus, as detailed below, follow-up measures were used as the outcome variables). The fourth avoidant subscale (other-blame) was not used in mediation models because it had a lower factor loading

(e.g., $\beta = .43$ at follow-up) on the avoidant coping latent variable and its inclusion reduced the fit of the measurement model.

The pre-registered protocol stated that posttest data would be used if there were no between-group differences in intervention conditions at follow-up. Per Hypothesis 1, there were no significant condition-by-time effects when the follow-up measures were included. Conducting the LMMs with posttest measures only (and excluding the follow-up measures) still demonstrated that there were no significant condition-by-time effects, suggesting no between-group differences at follow-up or posttest. Thus, to determine the mechanisms of intervention effectiveness, only the outcomes that had significant trauma-by-condition-by-time interaction effects were included in the multi-group SEM (i.e., DASS Depression, DASS Stress). The seven DASS Depression and seven DASS Stress items were each separated into three parcels, with DASS Depression and DASS Stress as separate latent variables. Given the inconsistent results across the different forms of distress, this also allowed for the SEM results to delineate mechanisms of intervention effectiveness only for outcomes that the intervention actually impacted. The factor loadings for the indicators of each latent variable were constrained to be equal across the multi-group model. The multi-group measurement model, in which all observed and latent variables were freely correlated with each other, had an RMSEA = .072, CFI = .908, and SRMR = .163, indicating acceptable fit. The fit of the multi-group structural model was RMSEA = .058, CFI = .937, and SRMR = .136.

In the emotional abuse history group ($N = 111$; see Figure 8), only decreases in avoidant coping at posttest were marginally significantly related to decreases in DASS

Depression at follow-up controlling for baseline depression and avoidant coping at follow-up ($B = .59, \beta = .20, p = .06$). Condition was not related to any of the proposed mediators at posttest. Thus, there were no significant indirect effects of the relations between condition and the outcomes (DASS Depression and DASS Stress). However, the direct path between condition and DASS Depression approached conventional standards of statistical significance ($B = -.40, \beta = -.15, p = .06$), suggesting that those with an emotional abuse history in the EMI condition had less DASS Depression at follow-up than those in the EMA condition.

In the no emotional abuse history group ($N = 247$; see Figure 9), decreases in avoidant coping were significantly related to both decreases in DASS Depression ($B = .55, \beta = .17, p = .01$) and DASS Stress ($B = .49, \beta = .17, p = .02$). Similar to the emotional abuse history group, condition was not related to any of the proposed mediators at posttest. Thus, there were no significant indirect effects of the relations between condition and the outcomes for the no emotional abuse history group as well. Contrary to the emotional abuse history group, the direct relation between condition and DASS Depression was significant and positive ($B = .31, \beta = .15, p < .001$), suggesting that those without an emotional abuse history in the EMI condition had higher depression scores at follow-up than those in the EMA condition.

Hypothesis 3: The EMI will be perceived as feasible, usable, and acceptable among the study sample

Completion rates were used as a measurement of feasibility and usability among the study sample (see Table 12). In the EMI condition ($n = 179$), the posttest and follow-up surveys had 89% ($n = 160$) and 91% ($n = 163$) completion rates, respectively. On average, participants in the EMI completed 22.5 out of 28 (80%) daily surveys (14 morning and 14 evening surveys). In the EMA condition ($n = 183$), the posttest and follow-up surveys had 87% ($n = 160$) and 91% ($n = 167$) completion rates, respectively. On average, participants in the EMA completed 23.0 out of 28 (82%) daily surveys (14 morning and 14 evening surveys). Chi-square tests indicated that completion rates between the EMI and EMA were similar across all time points and daily surveys, with the exception of Day 11's morning survey. On that survey, there was a higher completion rate for those in the EMA (88%) than those in the EMI (76%) condition, $\chi^2(1) = 8.18, p < .01, \Phi = -.15$. Regarding the number of mobile application page views (which were downloaded from the Yapp website) per participant on average by the end of the EMI/EMA period, participants in the EMI condition viewed the application homepage 29 times, the notifications page 22 times, the information page 18 times, the media (i.e., videos/audios) page 4 times, the schedule 2 times, and the present control written exercise 2 times. On average, participants in the EMA condition viewed the application homepage 23 times, the notifications page 17 times, the information page 13 times, the media page 2 times, and the schedule 3 times.

After viewing the psychoeducational video on the first daily evening survey, participants in both the EMI and EMA conditions completed four of the Feedback Survey (Guarino et al., 2016) questions as a measure of expectancy: 1) How logical does this type of program seem to you?; 2) How successful do you feel this program would be in decreasing stress?; 3) How confident would you be in recommending this treatment to a friend who had high stress; 4) How important is working on this problem for you? See Table 13 for means, standard deviations, and between-group effect sizes for expectancy measures. Participants in the EMI and EMA conditions similarly rated the logic of the program and the importance in working on their problems, $t(315) = 1.33, p = .19, d = 0.15$. Participants in the EMI group rated the program more highly than those in the EMA in terms of expectations of being successful in decreasing distress ($t(315) = 2.55, p = .01, d = 0.29$) and themselves as being confident in recommending this treatment ($t(313) = 2.04, p = .04, d = 0.23$), with small between-group effect sizes.

At posttest, these expectancy questions were worded differently to measure acceptability and the question on the importance of working on this problem was removed (see Table 13 for means, standard deviations, and between-group effect sizes for posttest measures). Because the expectancy questions were phrased in the future tense to measure expectations, these questions were modified (i.e., question removed or tense changed to past tense) to reflect how acceptable the participants evaluated the intervention upon completion of it. Statistically significant differences emerged between the EMI and EMA conditions on all three acceptability questions. Specifically, those in the EMI condition gave higher ratings on average than those in the EMA condition on all

acceptability-related questions, and between-group effect sizes became moderately sized ($ds = 0.53-0.77$). Paired t -tests indicated that participants had higher expectancy ratings at Day 1 than at posttest. In the EMI condition, participants decreased in how they rated how logical the program seemed ($t[133] = -5.33, p < .001, d = -0.92$), how successful the program seemed ($t[131] = -5.27, p < .001, d = -0.92$), and how confident they would be in recommending the program to a friend, $t(131) = -2.63, p = .01, d = -0.46$. Similarly, in the EMA condition, participants decreased in how they rated how logical the program seemed ($t[134] = -9.90, p < .001, d = -1.71$), how successful the program seemed ($t[138] = -9.66, p < .001, d = -1.64$), and how confident they would be in recommending the program to a friend, $t(131) = -8.15, p < .001, d = -1.42$.

At posttest, independent-groups t -tests indicated that participants in the EMI condition gave higher ratings than the EMA condition on all Feedback Survey (Guarino et al., 2016) visual analog scales with two exceptions: the intervention being easy to use and the intervention being potentially useful if more content were included. Specifically, those in the EMI condition on average gave higher ratings than those in the EMA condition regarding their intervention as interesting, useful, conveying new information, clarifying any misunderstandings, easy to understand, satisfactory, likable, and helpful in reducing distress (between-group $ds = 0.36-0.92$). Acceptability was measured by calculating mean scores on the 14 visual analog scales on the Feedback Survey, with a range of 0 (*not at all*) to 100 (*a great deal*). On the visual analog scales, average scores across participants in the EMI condition ranged from 57.3 to 86.0 out of 100 (see Table 13). Overall, the average score was 66.19 ($SD = 21.80$). Of the different scales,

participants' highest rating was on the intervention being easy to understand ($M = 86.0$, $SD = 17.3$) and participants' lowest rating was on the intervention conveying new information ($M = 57.3$, $SD = 23.9$). In the EMA condition, average scores across participants on the visual analog scales ranged from 37.9 to 82.3 out of 100. Overall, the average score was 52.29 ($SD = 25.85$). Of the different scales, participants' highest rating was on the intervention being easy to use ($M = 82.26$, $SD = 22.67$) and participants' lowest rating was on the intervention being helpful in reducing distress ($M = 37.88$, $SD = 26.78$).

Participants also rated the helpfulness of five aspects of the intervention (i.e., videos, the mobile application [e.g., mindfulness audios], written exercises, motivational messages, and reminders to view the mobile application; see Table 13). Average scores from participants in the EMI condition ranged from 2.97 to 3.87 out of 5. Overall, the average score was 3.47 ($SD = 1.16$). Of the various aspects, participants' highest helpfulness rating was on the reminder messages to view the mobile application ($M = 3.87$, $SD = 1.20$) and participants' lowest helpfulness rating was on the written exercises ($M = 2.97$, $SD = 1.14$). Participants in the EMA condition also rated the helpfulness of two aspects of the EMA (i.e., video and the mobile application). With regard to these specific aspects of the intervention administered to both conditions, those in the EMI condition rated the videos as 3.19 out of 5 on average ($SD = 1.13$) in terms of helpfulness while those in the EMA condition rated the videos as 2.51 on average ($SD = 1.09$). For the mobile application itself, those in the EMI condition rated it a 3.69 out of 5 on average ($SD = 1.17$) in terms of helpfulness while those in the EMA condition rated it as

2.96 on average ($SD = 1.33$). Overall, participants in the EMI condition gave higher ratings on average than those in the EMA condition regarding the helpfulness of the videos (between-group $d = 0.61$) and the mobile application (between-group $d = 0.58$).

Post-hoc Analyses

Because the EMI did not appear as effective as web-based (e.g., computer) versions of the present control intervention in previous studies (see Table 1), post-hoc analyses outside of the pre-registered protocol were performed to examine differences between the mobile intervention (i.e., EMI) and a web-based version of the present control intervention (Nguyen-Feng et al., 2015; see Table 14). In the present study, the written exercises were rated the lowest ($M = 2.97$ [out of 5], $SD = 1.14$) in terms of helpfulness in the EMI condition. However, the written exercises have been rated the highest in prior research (e.g., $M = 3.67$ out of 5; Frazier et al., 2015). Thus, character counts indicating the length of participants' responses on the written exercises were compared between the EMI and a web-based version of the present control intervention in a similar university sample (Nguyen-Feng et al., 2015). Across six open-response questions (i.e., asking participants to describe a stressor or what bothered them most that day and five questions on increasing present control), participants in the web-based version wrote 2.80 times more on average per response than those in the mobile intervention (between-group $d = 1.10$). This result was consistent across all days and all the various written exercise questions. Averaging responses across days, participants in the mobile intervention wrote 47.81 characters ($SD = 48.98$) per question whereas participants in the web-based intervention wrote 133.20 characters ($SD = 98.61$) per

question. Overall, participants using a web-based version of the intervention (Nguyen-Feng et al., 2015) wrote significantly more on the present control written exercises than those using the mobile intervention in the current sample. However, unlike a prior study (Meredith, 2016), character counts in the present sample were not significantly correlated with change scores in the outcome measures.

Though participants in the EMI ($M = 2.85$, $SD = 1.16$) rated the psychoeducational videos similar in helpfulness as participants in the previous web-based intervention ($M = 2.95$, $SD = 1.07$; Nguyen-Feng et al., 2015), those in the previous web-based intervention ($M = 3.20$, $SD = 1.19$; Nguyen-Feng et al., 2015) gave higher ratings to the helpfulness of the written exercises than those in the EMI ($M = 2.97$, $SD = 1.14$) condition, $t(500) = -1.96$, $p = .05$, $d = 0.19$.

Discussion

The primary aim of the present study was to assess the feasibility and efficacy of an EMI to reduce psychological distress among students with and without a history of childhood emotional abuse. The study examined whether an EMI focused on increasing present control and mindfulness could reduce distress (e.g., depression, anxiety, stress symptoms) and would be feasible and acceptable within this population. The present study added to the current literature by being the first randomized controlled trial to compare the efficacy of an EMI to an EMA in reducing psychological distress and with this particular population of interest (i.e., college students, including those with a history of emotional abuse). Additionally, this is the first EMI study to employ a randomized controlled design with an active comparison group (i.e., EMA) and a large sample size (N

= 382; EMI $N = 179$; EMA $N = 183$). The study expanded on the limited research on emotional abuse by further elucidating the long-term effects of childhood emotional abuse (e.g., comparing whether students with a history of emotional abuse report more baseline distress) as well as examined if a present control intervention would be beneficial to students who have experienced such abuse. The study design was also unique in that it employed an EMI that involved a follow-up assessment.

Overall, the results suggested that the EMI and EMA did not significantly differ in reducing distress for the general student population, contrary to Hypothesis 1. Due to studies suggesting that the act of self-monitoring increases awareness of behaviors that leads to behavioral change (e.g., Arney, 2012; Beckjord & Shiffman, 2014), only a small-to-moderate between-group effect size had been predicted, with a larger within-group effect size for the EMI condition than the EMA condition. However, there were no significant differences between these two conditions in the general student sample. Both the EMI and EMA conditions significantly decreased perceived stress and increased positive affect (two of the six outcomes), and the EMA group decreased in anxiety over time.

Examining emotional abuse as a moderator (Hypothesis 1a), the EMI appeared generally more effective for those with an emotional abuse history than for those without an emotional abuse history, which was hypothesized. By contrast, the EMA appeared generally more effective for those without an emotional abuse history than for those with an emotional abuse history, which was an unexpected finding. Though it was hypothesized that there would be an interaction between emotional abuse history and

intervention condition and that the EMI would be as or more effective for those with (versus without) a history of emotional abuse, the specific moderator effect of the EMA being more effective for those without (versus with) a history of emotional abuse was not explicitly hypothesized. The EMI being slightly more efficacious for those with an emotional abuse history follows previous research suggesting that an online intervention teaching present control skills is more beneficial to survivors of interpersonal trauma than to those without such a history (e.g., Nguyen-Feng et al., 2015). This may be because those with a history of emotional abuse reported more baseline distress (Hypothesis 0) and thus were in greater need of an intervention to decrease psychological distress. The present control intervention has also been found to be more effective for those with higher, rather than lower, distress levels at baseline (Coudray, Wang, Palmer, & Frazier, 2017). For the outcome measures that did significantly change in the group with a history of emotional abuse (depression, stress symptoms, perceived stress, positive affect), the effect sizes ($|ds| = 0.25-0.53$; average $|d| = 0.40$) were similar to other web-based interventions teaching both present control and mindfulness to those with a history of interpersonal trauma (average $|ds| = 0.34$ and 0.35 ; Nguyen-Feng et al., 2016; Nguyen-Feng et al., 2017). The within-group effect sizes for similar measures in the present study for the EMI in the general student sample were negligible ($ds = -0.03$ to 0.02), especially in comparison to the present control intervention delivered to general student samples in previous studies (average $ds = -0.49$ to -0.18 ; Hintz et al., 2015; Frazier et al., 2015; Meredith, 2016; Meredith & Frazier, 2017).

The lack of efficacy for the EMI, especially relative to the EMA, was contrary to hypotheses and previous research supporting the potential for EMIs to promote healthy behaviors. However, most of this research has focused on specifically behavioral changes such as lowering alcohol or substance use (e.g., Mason et al., 2015), increasing physical activity (Buchholz et al., 2013), increasing medication adherence, or increasing healthy eating (for a review, see e.g., Hall et al., 2015). In a seminal review of EMIs (Heron & Smyth, 2010), EMIs were suggested to be effective to reduce anxiety symptoms. However, of the six studies incorporated into this review, three were case studies and the other three incorporated an in-person cognitive-behavioral therapy component. Though other EMI studies have been conducted since this review, as described below, none have employed a randomized controlled design with an active comparison group and a large sample size.

These more recent EMI studies that primarily aimed to decrease psychological distress have all employed small sample sizes ($Ns < 100$) and many examined only feasibility, usability, and acceptability rather than efficacy (e.g., $N = 9$, Pramana et al., 2014; $N = 21$, Wolf et al., 2016). EMIs that did examine efficacy also tended to be single-arm studies rather than randomized controlled trials, though the studies did demonstrate significant within-group reductions in psychological symptoms such as depression and anxiety (e.g., $N = 8$, Burns et al., 2011; $N = 99$; Mohr et al., 2017). These EMI studies selected for participants with clinical diagnoses, which is different from the present sample of college students who were not explicitly seeking help. Of recent randomized clinical trials employing an EMI, one had an in-person group therapy

component ($N = 34$; Newman et al., 2014) and the other was a one-week micro-intervention for students with social anxiety ($N = 83$; Kivity & Huppert, 2016). The randomized clinical trial with group therapy was effective, though not necessarily more effective than group therapy alone. The randomized clinical trial for students with social anxiety only had differential between-group effects for those with lower severity of anxiety symptoms and not high social anxiety; this is opposite of the results of the present study, in which those with a history of emotional abuse reported more distress and benefited most from the EMI. Nonetheless, it seems that though research on EMIs to promote healthy behaviors has been robust and thriving, the literature on EMIs to decrease psychological distress is scant, with few studies with strong methodologies.

Despite the lack of strong evidence, it is possible that EMIs to reduce psychological distress might be viable and the limitations of this study, explored later, may have hampered significant findings. As even web-based interventions that have been deemed effective (e.g., internet-based cognitive-behavioral therapy) have groups of participants who deteriorate over time (for a review, see Rozental, Magnusson, Boettcher, Andersson, & Carlbring, 2017), it is possible that the EMI did not fit the participants in this particular study. On the other hand, especially given the scant literature, the results of the present study might be representative of the current state of the field. That is, EMIs alone may not be the best method to decrease psychological distress, though there are potential moderators (e.g., interpersonal trauma history, baseline distress) of this relationship that warrant exploration. With regard to the potential ineffectiveness of EMIs, a systematic review of 56 studies (Eichenberg, Küsel, & Hübner, 2017) suggested

that mobile applications for the treatment of posttraumatic stress disorder were promising, trending in the hypothesized direction, but not effective. Online or web-based interventions delivered on a computer platform, however, demonstrated medium to large effect sizes in decreasing posttraumatic stress disorder symptoms in this review. This follows the evidence suggesting that web-based interventions are equivalent to face-to-face therapies (for a review, see e.g., Carlbring et al., 2018), though mobile applications are still considered to be in their “infancy” (Schnurr et al., 2017) and research on EMIs is still nascent. Additionally, the manner in which individuals use technology has changed over time, particularly since Heron and Smyth’s (2010) seminal review.

According to the Pew Research Center (2018), smartphone ownership has increased from 35% of United States adults in 2011 to 77% of adults in 2018. This increase has helped lessen the digital gap between whites and Hispanics and blacks, in that they all have similar rates of smartphone ownership (75-77%; Pew, 2018). Not only has ownership changed over time, but also the uses of smartphone have diversified over the past decade. A fair portion of United States adults use their smartphone for nontraditional tasks such as dating on mobile applications (9%), shopping (51%), and receiving news alerts (55%; Pew, 2017). Smartphone owners view their devices as a method of connecting (72%) or as a distracting tool (28%; Pew, 2017). The use of mobile phones on the go is also viewed as acceptable, in that 74-77% of adults report that it is generally okay to use a mobile phone while walking down the street, on public transportation, or while waiting in line (Pew, 2017). In one study of university students (Kopackova & Bilkova, 2014), less than 10% of participants reported using their mobile

devices for reading or notes, whereas more than half used their devices for other activities such as games, sharing, and location-based applications. This mentality of mobile phones as a quick and accessible tool used for multifaceted, leisure purposes could hamper the potential of a mobile phone to be used for psychoeducational, learning purposes.

Thus, engagement of participants could be a critical aspect to measure in future studies. However, the concept of adherence is difficult to operationalize. The majority of studies in a review (Sieverink, Kelders, & van Gemert-Pijnen, 2017) defined adherence to be synonymous with more use, though that is not necessarily the case if participants are able to use mobile phones rather mindlessly, e.g., while walking down the street, on public transportation. In the present study, feasibility, usability, and acceptability (Hypothesis 3) did not necessarily translate to outcome changes.

Completion rates in the EMI condition (91% at follow-up; 80% for daily surveys) were on par with adherence rates from other studies that were deemed to be feasible (e.g., 77% to 92%; Depp et al., 2015; Guarino et al., 2016). Acceptability ratings (range = 57.3 to 86.0 out of 100) were also on par with another study that employed this feedback survey and deemed their EMI as acceptable (i.e., range = 58.5 to 82.3 out of 100; Guarino et al., 2016). However, with regard to helpfulness ratings, this study had a wider range of ratings (2.97 to 3.87 out of 5) compared to other studies that have employed the web-based version of this present control intervention and measured helpfulness (i.e., range = 3.52 to 3.87 out of 5; Hintz et al., 2015; Frazier et al., 2015).

This suggests that there was more variability in the perceived helpfulness of the intervention among those in the EMI compared to those in previous web-based intervention studies teaching similar skills. This discrepancy could reflect differences in how students perceive the use of their mobile devices versus using a computer to learn psychoeducational skills. To increase effectiveness of technologies to reduce psychological distress, some have suggested using artificially intelligent virtual human support guides (notably in the trauma field; Schnurr et al., 2017), particularly as guided web-based interventions have been found to be more effective than non-guided interventions (for a review, see Heber et al., 2017). As technology rapidly changes, the use of technology in providing psychotherapeutic care also needs to change in tandem.

Another method for improving the effectiveness of technological interventions is understanding mechanisms of change for the targeted group. The present study experimentally manipulated the proposed mediators of change (Hypothesis 2), allowing the possibility of making stronger claims about causation that cannot be made in cross-sectional, non-experimental mediation models (Cole & Maxwell, 2003). However, though decreased avoidant coping at posttest was related to less depression and stress (the outcomes that had significant trauma-by-time-by-condition interactions) at follow-up, none of the proposed mediators (i.e., present control, mindfulness, rumination, avoidant coping) were significant. This is contrary to prior studies that have suggested that present control mediated intervention efficacy (Hintz et al., 2015; Nguyen-Feng et al., 2015) and that rumination mediated intervention efficacy specifically for those with an interpersonal trauma history (Nguyen-Feng et al., 2015).

Future researchers may need to note these differences in teaching psychoeducational skills such as present control and mindfulness on a mobile device, which is a tool more likely colloquially associated with mindlessness rather than mindfulness, rather than a computer. That is, the platform used to teach such skills may make an impact on how well the skills are learned, especially given inherent difficulties of general education learning on a mobile device (c.f., mobile-assisted language learning for English as a second language learners; Hashim, Yunus, Embi, & Ozir, 2017). For instance, users need to re-habituate themselves from using mobile phones for leisure activities to using them for educational activities (for a review, see Shudong & Higgins, 2006). Screen sizes have an impact on both subjective and objective learning experiences as well. Though participants may report overall positive experiences on mobile learning regardless of screen size, those with larger screen sizes closer to a personal digital assistant report more subjective satisfaction (e.g., in recommending mobile learning, in it being “fun”) and answered more questions correctly in an objective assessment than those with smaller screen sizes (Maniar, Bennet, Hand, & Allan, 2008). Though this research question has not been explicitly studied on mobile vs. computer-sized screens, the idea that larger screens promote learning is still translatable. These platform differences (e.g., mobile versus web-based) were highlighted in the post-hoc analyses, which found that participants in the EMI wrote significantly less on written exercises than participants who answered the questions on a computer, web-based intervention in previous studies. Relatedly, participants in the EMI rated the written exercises as less helpful than those who completed the exercises in the web-based intervention, though

participants in both studies rated the helpfulness of the psychoeducational videos similarly.

The study was subject to several limitations that may affect the conclusions that can be drawn from this research. First, in particular, the population from which the study sample was drawn limits the generalizability of the results. Because the participants were recruited from psychology classes at a four-year university and were compensated with extra credit points (versus monetary compensation or help seeking in a clinical setting), the sample may be more resilient than individuals who have experienced emotional abuse and are not college students. Similar to other university samples, these undergraduate students in psychology also tended to be White and female, which further limits the generalizability and representativeness of the sample. Second, because the intervention was conducted following an academic calendar, a longer follow-up was not necessarily feasible within this setting. The pretest was administered immediately after spring break and the follow-up assessment was administered during finals week, which is typically a stressful time for college students. Thus, the intervention at best might have had a preventive effect in terms of preventing increases distress over the course of the semester. This would follow previous research suggesting that a web-based, present control intervention was effective in preventing increases in distress relative to a waitlist comparison group (Nguyen-Feng et al., 2015). Third, the app itself had limitations. For instance, the app was unable to measure other components of interest, such as individual user data so that the relations between dosage and outcome could be assessed.

In addition to these limitations associated with study characteristics, there were several nuances in the micro-longitudinal data collected that may impact data analysis. First, in prior daily diary research with a similar undergraduate sample (e.g., Baker et al., 2018), data were not missing at random; presumably because of less stress on the weekends, participants were less likely to complete the daily diary surveys or to endorse experiencing a stressor over the weekends. Though the present study provided time filler questions for those who did not endorse a stressor, there was still a general trend for fewer daily assessment responses on the weekends. Second, for participants in the present study, the practice of monitoring their emotions, symptoms, and behaviors could have also impacted how they responded to posttest and follow-up assessments. Specifically, the posttest assessments might have been a more accurate reflection of participant's daily emotions, symptoms, and behaviors than at pretest, as the participants at posttest had recently practiced completing the daily measures for 14 days. This could affect the relative validity of scores across time points. Third, demand characteristics could have also impacted how participants responded to these assessments in that participants in both the EMI and EMA conditions might have felt inclined to report improved symptoms over time, given participant knowledge that they were participating in a stress management study. Fourth, regarding other measures, the PHI was administered to participants who did not report experiencing a stressor on a given day. Though these questions asking about well-being and happiness were intended to control for assessment time for individuals who did not report a stressor and thus did not complete the stress-related questions, the PHI itself could have intentionally acted as a

positive psychology intervention. Fifth, there is a possible of family-wise error due to the number of tests on various outcomes rather than using an aggregate measure of distress; however, there did appear to be nuanced differences in symptoms such as depression and stress.

There are limitations in the measure of childhood emotional abuse as well. Childhood emotional abuse was dichotomized following the cut point recommendations of Bernstein et al. (2003). However, the dichotomization of measures may lead to the loss of information, reducing the power to detect significant relationship between variables (Altman & Royston, 2006). Though it is difficult to assert that an individual with a higher childhood emotional abuse score on a continuous measure has worse severity or incidences of such experiences than those with lower scores, the sequelae of childhood emotional abuse might have been weakened in the present study by using a dichotomous measure. Additionally, because those with a history of childhood emotional abuse reported more distress at baseline than others, childhood emotional abuse might have simply been serving as a proxy for distress. These limitations may provide challenges in interpreting results.

Nonetheless, the present study has important implications for both practice and research in addition to contributing to both the fields of technology-based interventions and trauma psychology. By examining if alternatives to face-to-face interventions are feasible and efficacious for the general student body and at-risk groups, then college counseling centers may consider this approach to provide psychotherapeutic services to more individuals. Because EMIs appear feasible yet not efficacious for the general

student body, then college counseling centers might rather streamline resources to further promote web-based interventions rather than develop new EMIs. There may still be potential benefits of EMIs, as 18-29 year olds are the largest adult age group who do not have Internet at home yet own a smartphone (17%; Pew, 2018); thus mobile interventions may reach more of this age group than computer, web-based interventions. If EMIs are employed as a manner to reach more students, individuals should be screened for factors that may predict greater success in using an EMI (e.g., interpersonal trauma history, distress level). By understanding what type of intervention works best for which at-risk groups, then future interventions can be refined. Future interventions could also target certain at-risk groups, based on their trauma history or baseline levels of distress. Research that directly compares EMI and web-based interventions in the same study is also needed to determine what works best for certain groups. Given the limited research on EMIs for college students (aside from those that focus on decreasing substance use), future research and clinical practices may also benefit from understanding how feasible, usable, acceptable, and efficacious EMIs are in reducing distress among the college student population.

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Table 1

Summary of Present Control Intervention Efficacy Studies

Study	Sample	Time points	Conditions	Within-group effect sizes ^{a, b}	Between-group effect size ^{a, c}
1. Hintz, Frazier, & Meredith, 2015	233 university students scoring low on present control	Pre Post Follow-up (3 weeks)	PCI PCI+Support SIO	-.42 -.50 -.11	PCI: Posttest = .32 Follow-up = .31 PCI+Support: Posttest = .29 Follow-up = .38
2. Frazier et al., 2015	194 community college students	Pre Post Follow-up (3 weeks)	PCI SIO	-.49 -.37	PCI: Posttest = .35 Follow-up = .12
3. Nguyen-Feng et al., 2015	500 university students	Pre Post	PCI Wait list		PCI: IPT = -.44 No IPT = -.10
4. Nguyen-Feng et al., 2016	314 university students	Pre Post	PCI PCI+MF Enhanced PCI	IPT: -.26 No IPT: -.17 IPT: -.34 No IPT: -.39 IPT: -.48 No IPT: -.37	
5. Nguyen-Feng et al., 2017b	320 university students	Pre Post Follow-up (2-3, 4-5 weeks)	MF PCI+MF SIO	IPT: -.03 No IPT: -.50 IPT: -.35 No IPT: -.46 IPT: -.40 No IPT: -.34	
6. Meredith & Frazier, 2017	213 community college students	Pre Post Follow-up (3 weeks)	PCI PCI+MF Enhanced PCI	-.46 -.57 -.51	
7. Meredith, 2016	527 community college students in a college readiness class	Pre Post Follow-up (3, 6 weeks)	PCI PCI+Feedback Comparison	-.18 .02 .02	PCI 6-week follow-up = .16 PCI+Feedback 6-week follow-up = .00

Note. PCI = Present Control Intervention. SIO = Stress information only. MF = Mindfulness. IPT = interpersonal trauma. ^aAveraged across Depression Anxiety Stress Scales (DASS) and Perceived Stress Scale with the exception of Study 7, in which the Counseling Center Assessment of Psychological Symptoms scale is used in place of the DASS. ^bWithin-group effect size reflecting change from

preintervention to last time point in study. ^cDifference between intervention condition and comparison group

Table 2

Means and Standard Deviations across Time Points by Condition

Measure	Pretest	Posttest	Follow-up
Ecological Momentary Intervention (<i>n</i> = 179)			
DASS Depression	0.68 (0.60)	0.68 (0.61)	0.65 (0.66)
DASS Anxiety	0.62 (0.56)	0.61 (0.54)	0.64 (0.57)
DASS Stress	0.93 (0.65)	0.91 (0.58)	0.90 (0.65)
Perceived Stress	1.92 (0.68)	1.83 (0.66)	1.83 (0.75)
PANAS Positive Affect	3.04 (0.79)	3.11 (0.81)	3.26 (0.83)
PANAS Negative Affect	2.35 (0.73)	2.29 (0.76)	2.43 (0.79)
Present Control	2.95 (0.51)	2.98 (0.44)	2.95 (0.54)
FFMQ Non-reactivity	1.76 (0.71)	2.94 (0.80)	2.94 (0.85)
R-COPE Avoidance	1.47 (0.44)	1.29 (0.45)	1.30 (0.41)
R-COPE Rumination	2.82 (0.89)	2.08 (0.80)	2.17 (0.93)
Ecological Momentary Assessment (<i>n</i> = 183)			
DASS Depression	0.69 (0.65)	0.71 (0.65)	0.61 (0.68)
DASS Anxiety	0.53 (0.50)	0.51 (0.50)	0.45 (0.46)
DASS Stress	0.86 (0.58)	0.87 (0.64)	0.82 (0.59)
Perceived Stress	1.86 (0.73)	1.78 (0.70)	1.76 (0.69)
PANAS Positive Affect	3.09 (0.76)	3.14 (0.67)	3.23 (0.74)
PANAS Negative Affect	2.22 (0.69)	2.10 (0.76)	2.30 (0.70)
Present Control	2.97 (0.52)	2.94 (0.52)	2.97 (0.54)
FFMQ Non-reactivity	2.80 (0.68)	2.91 (0.73)	2.98 (0.73)
R-COPE Avoidance	1.42 (0.41)	1.33 (0.42)	1.32 (0.44)
R-COPE Rumination	2.67 (0.91)	2.14 (0.85)	2.12 (0.90)

Note. DASS = Depression Anxiety Stress Scale. FFMQ = Five Facet Mindfulness Questionnaire. *Ns* = 154-181.

Table 3

Means and Standard Deviations across Time Points by Condition and Emotional Abuse History

Measure	Pretest	Posttest	Follow-up
Ecological Momentary Intervention: History of Emotional Abuse (<i>n</i> = 55)			
DASS Depression	1.01 (0.63)	1.00 (0.70)	0.73 (0.67)
DASS Anxiety	0.81 (0.60)	0.88 (0.57)	0.80 (0.60)
DASS Stress	1.25 (0.72)	1.23 (0.61)	1.06 (0.67)
Perceived Stress	2.13 (0.70)	2.11 (0.62)	1.98 (0.72)
PANAS Positive Affect	2.89 (0.79)	2.88 (0.79)	2.88 (0.79)
PANAS Negative Affect	2.64 (0.81)	2.63 (0.79)	2.64 (0.80)
Present Control	2.75 (0.53)	2.93 (0.44)	2.83 (0.57)
FFMQ Non-reactivity	2.65 (0.73)	2.77 (0.80)	2.85 (0.84)
R-COPE Avoidance	1.55 (0.50)	1.35 (0.57)	1.32 (0.37)
R-COPE Rumination	3.22 (0.68)	2.31 (0.84)	2.37 (0.90)
Ecological Momentary Intervention: No History of Emotional Abuse (<i>n</i> = 122)			
DASS Depression	0.53 (0.52)	0.54 (0.51)	0.61 (0.66)
DASS Anxiety	0.54 (0.52)	0.49 (0.48)	0.58 (0.55)
DASS Stress	0.78 (0.57)	0.76 (0.51)	0.83 (0.63)
Perceived Stress	1.83 (0.65)	1.71 (0.64)	1.77 (0.75)
PANAS Positive Affect	3.11 (0.79)	3.22 (0.80)	3.32 (0.79)
PANAS Negative Affect	2.22 (0.66)	2.13 (0.69)	2.33 (0.77)
Present Control	3.03 (0.47)	3.01 (0.45)	3.00 (0.52)
FFMQ Non-reactivity	2.81 (0.70)	3.02 (0.79)	2.98 (0.85)
R-COPE Avoidance	1.44 (0.41)	1.26 (0.37)	1.29 (0.43)
R-COPE Rumination	2.64 (0.92)	1.97 (0.77)	2.08 (0.93)
Ecological Momentary Assessment: History of Emotional Abuse (<i>n</i> = 56)			
DASS Depression	0.93 (0.72)	0.93 (0.67)	0.97 (0.81)
DASS Anxiety	0.68 (0.54)	0.66 (0.51)	0.61 (0.49)
DASS Stress	1.08 (0.58)	1.06 (0.52)	1.08 (0.54)
Perceived Stress	2.16 (0.71)	2.01 (0.56)	2.04 (0.69)
PANAS Positive Affect	2.86 (0.75)	2.93 (0.58)	2.98 (0.71)
PANAS Negative Affect	2.48 (0.66)	2.40 (0.75)	2.59 (0.73)
Present Control	2.76 (0.53)	2.83 (0.49)	2.88 (0.50)
FFMQ Non-reactivity	2.69 (0.69)	2.82 (0.76)	2.80 (0.62)
R-COPE Avoidance	1.52 (0.45)	1.46 (0.47)	1.44 (0.48)
R-COPE Rumination	2.90 (0.87)	2.33 (0.90)	2.41 (0.96)
Ecological Momentary Assessment: No History of Emotional Abuse (<i>n</i> = 125)			
DASS Depression	0.58 (0.58)	0.60 (0.62)	0.45 (0.54)
DASS Anxiety	0.47 (0.48)	0.43 (0.48)	0.38 (0.44)
DASS Stress	0.76 (0.55)	0.78 (0.66)	0.71 (0.58)
Perceived Stress	1.73 (0.70)	1.68 (0.73)	1.64 (0.66)
PANAS Positive Affect	3.19 (0.74)	3.23 (0.69)	3.34 (0.73)
PANAS Negative Affect	2.11 (0.68)	1.97 (0.74)	2.18 (0.66)
Present Control	3.07 (0.49)	2.99 (0.53)	3.00 (0.56)
FFMQ Non-reactivity	2.85 (0.67)	2.95 (0.71)	3.06 (0.76)
R-COPE Avoidance	1.38 (0.38)	1.26 (0.37)	1.27 (0.41)
R-COPE Rumination	2.57 (0.91)	2.05 (0.82)	1.99 (0.84)

Note. DASS = Depression Anxiety Stress Scale. FFMQ = Five Facet Mindfulness Questionnaire. *Ns* = 48-125.

Table 4

Pretest Correlations among Study Variables

Measure	1	2	3	4	5	6	7	8	9	10
All participants (<i>Ns</i> = 359-362)										
1. DASS Depression	—									
2. DASS Anxiety	.49	—								
3. DASS Stress	.63	.65	—							
4. Perceived Stress	.66	.53	.66	—						
5. Positive Affect	-.48	-.13	-.20	-.42	—					
6. Negative Affect	.60	.58	.70	.65	-.15	—				
7. Present Control	-.39	-.36	-.39	-.54	.34	-.38	—			
8. Non-reactivity	-.28	-.22	-.35	-.46	.27	-.35	.46	—		
9. R-COPE Avoidance	.31	.26	.29	.29	-.10	.32	-.34	-.11	—	
10. R-COPE Rumination	.45	.34	.50	.51	-.24	.43	-.43	-.37	.24	—

Note. DASS = Depression Anxiety Stress Scale. ns = non-significant ($p \geq .05$). $ps < .05$ unless noted otherwise.

Table 5

Means, Standard Deviations, and Correlations at Baseline by Emotional Abuse History

Measure	History of Emotional Abuse	No History of Emotional Abuse	<i>t</i>	Between -group <i>d</i>	<i>r</i>
DASS Depression	0.97 (0.67)	0.56 (0.55)	6.11***	0.67	.35***
DASS Anxiety	0.74 (0.57)	0.50 (0.50)	4.07***	0.45	.25***
DASS Stress	1.17 (0.66)	0.77 (0.56)	5.85***	0.65	.32***
Perceived Stress	2.15 (0.70)	1.78 (0.68)	4.72***	0.54	.29***
PANAS Positive Affect	2.88 (0.77)	3.15 (0.77)	-3.10***	-0.35	-.14*
PANAS Negative Affect	2.56 (0.74)	2.16 (0.67)	4.99***	0.56	.31***
Present Control	2.76 (0.53)	3.05 (0.48)	-5.13***	-0.58	-.26***
FFMQ Non-reactivity	2.67 (0.71)	2.83 (0.68)	-2.06*	-0.23	-.08
R-COPE Avoidance	1.54 (0.48)	1.41 (0.40)	2.68*	0.53	.21***
R-COPE Rumination	3.06 (0.80)	2.60 (0.91)	4.53***	0.55	.23***

Note. Correlations (*rs*) were conducted using the continuous measure of emotional abuse. DASS = Depression Anxiety Stress Scale. FFMQ = Five Facet Mindfulness Questionnaire. Due to missing data, *Ns* = 110-111 for history of emotional abuse and *Ns* = 246-247 for no history of emotional abuse. Negative *t* and *d* values indicate smaller values in the history of emotional abuse group. * $p < .05$ *** $p < .001$

Table 6

Linear Mixed Models Contrasts of Intervention Effects Comparing Difference between Pretest and Follow-up by Condition and Emotional Abuse History

Measure	EMI	EMA
All Participants ($N = 362$)		
DASS Depression	-.02	-.05
DASS Anxiety	.02	-.08*
DASS Stress	-.03	-.03
Perceived Stress	-.09 ⁺	-.08 ⁺
PANAS Positive Affect	.21***	.14*
PANAS Negative Affect	.08	.10 ⁺
History of Emotional Abuse ($N = 111$)		
DASS Depression	-.26***	.03
DASS Anxiety	-.02	-.09
DASS Stress	-.18*	-.03
Perceived Stress	-.14 ⁺	-.12
PANAS Positive Affect	.21*	.13
PANAS Negative Affect	-.01	.10
No History of Emotional Abuse ($N = 247$)		
DASS Depression	.09 ⁺	-.09 ⁺
DASS Anxiety	.05	-.08 ⁺
DASS Stress	.05	-.05
Perceived Stress	-.05	-.07
PANAS Positive Affect	.22***	-.19
PANAS Negative Affect	.13*	.08

Note. EMI = Ecological Momentary Intervention. EMA = Ecological Momentary Assessment. DASS = Depression Anxiety Stress Scale. Values are estimated coefficients from linear mixed model analyses reflecting change over time within groups. Negative values indicate greater marginal means at pretest (i.e., decreases in marginal means over time). ⁺ $p < .10$ * $p < .05$ *** $p < .001$

Table 7

Within-group Effect Sizes Comparing Difference between Pretest and Follow-up by Condition and Emotional Abuse History (Cohen's D)

Measure	EMI ($n = 179$)	EMA ($n = 183$)
All Participants ($N = 362$)		
DASS Depression	-0.07	-0.22
DASS Anxiety	0.06	-0.28
DASS Stress	-0.08	-0.10
Perceived Stress	-0.19	-0.27
PANAS Positive Affect	0.42	0.30
PANAS Negative Affect	0.15	0.19
History of Emotional Abuse ($N = 111$; EMI = 55; EMA = 56)		
DASS Depression	-0.53	0.09
DASS Anxiety	-0.04	-0.19
DASS Stress	-0.43	-0.01
Perceived Stress	-0.25	-0.25
PANAS Positive Affect	0.40	0.27
PANAS Negative Affect	-0.01	0.28
No History of Emotional Abuse ($N = 247$; EMI = 122; EMA = 125)		
DASS Depression	0.23	-0.43
DASS Anxiety	0.11	-0.32
DASS Stress	0.11	-0.15
Perceived Stress	-0.15	-0.27
PANAS Positive Affect	0.43	0.31
PANAS Negative Affect	0.23	0.16

Note. EMI = Ecological Momentary Intervention. EMA = Ecological Momentary Assessment. DASS = Depression Anxiety Stress Scale. Positive d values indicate increases in scores over time and negative d values indicate decreases in scores over time.

Table 8

Between-group Effect Sizes Comparing Difference between Pretest and Follow-up by Condition and Emotional Abuse History (Cohen's D)

Measure	EMA vs. EMI	EMI: No EA vs. EA	EMA: No EA vs. EA	No EA: EMA vs. EMI	EA: EMA vs. EMI
DASS Depression	-0.15	0.76	-0.52	-0.66	0.62
DASS Anxiety	-0.34	0.15	-0.13	-0.44	-0.15
DASS Stress	-0.03	0.54	-0.13	-0.26	0.41
Perceived Stress	-0.08	0.10	-0.02	-0.12	0.00
PANAS Positive Affect	0.12	-0.03	-0.04	0.13	0.13
PANAS Negative Affect	0.04	-0.22	-0.12	-0.07	0.27

Note. EA = Emotional Abuse. EMI = Ecological Momentary Intervention. EMA = Ecological Momentary Assessment. DASS = Depression Anxiety Stress Scale. $N = 362$. Negative d values indicate the first group in comparison had larger within-group effect sizes and positive d values indicate the second group in the comparison had larger within-group effect sizes.

Table 9

Linear Mixed Models Contrasts of Intervention Effects Comparing Difference between Pretest and Follow-up by Condition and Childhood Sexual Abuse History

Measure	EMI	EMA
All Participants ($N = 362$)		
DASS Depression	-.11 ⁺	.02
DASS Anxiety	.00	.01
DASS Stress	-.05	-.06
Perceived Stress	-.19*	-.11
PANAS Positive Affect	.30***	.14 ⁺
PANAS Negative Affect	.02	.14 ⁺
History of Childhood Sexual Abuse ($N = 47$)		
DASS Depression	-.33*	.11
DASS Anxiety	-.11	.13
DASS Stress	-.34*	-.10
Perceived Stress	-.33*	-.12
PANAS Positive Affect	.40*	.15
PANAS Negative Affect	-.07	.18
No History of Childhood Sexual Abuse ($N = 313$)		
DASS Depression	.03	-.07
DASS Anxiety	.16*	-.11*
DASS Stress	.03	-.02
Perceived Stress	-.05	-.08
PANAS Positive Affect	.19*	.14*
PANAS Negative Affect	.11 ⁺	.08

Note. EMI = Ecological Momentary Intervention. EMA = Ecological Momentary Assessment. DASS = Depression Anxiety Stress Scale. Values are estimated coefficients from linear mixed model analyses reflecting change over time within groups. Negative values indicate greater marginal means at pretest (i.e., decreases in marginal means over time). ⁺ $p < .10$ * $p < .05$ *** $p < .001$

Table 10

Linear Mixed Models Contrasts of Intervention Effects Comparing Difference between Pretest and Follow-up by Condition and Sexual Victimization History

Measure	EMI	EMA
All Participants ($N = 362$)		
DASS Depression	-.05*	.02
DASS Anxiety	.03	-.02
DASS Stress	-.12*	-.01
Perceived Stress	-.15*	-.07
PANAS Positive Affect	.25***	.15*
PANAS Negative Affect	.04	.17*
History of Sexual Victimization ($N = 69$)		
DASS Depression	-.26*	.13
DASS Anxiety	.03	.07
DASS Stress	.23*	.01
Perceived Stress	-.25*	-.05
PANAS Positive Affect	.29*	.17
PANAS Negative Affect	-.03	.27*
No History of Sexual Victimization ($N = 291$)		
DASS Depression	-.09*	-.09*
DASS Anxiety	.02	-.11*
DASS Stress	.04	-.04
Perceived Stress	.03	-.09 ⁺
PANAS Positive Affect	.20*	.13*
PANAS Negative Affect	.33*	.06

Note. EMI = Ecological Momentary Intervention. EMA = Ecological Momentary Assessment. DASS = Depression Anxiety Stress Scale. Values are estimated coefficients from linear mixed model analyses reflecting change over time within groups. Negative values indicate greater marginal means at pretest (i.e., decreases in marginal means over time). ⁺ $p < .10$ * $p < .05$ *** $p < .001$

Table 11

Linear Mixed Models Contrasts of Intervention Effects Comparing Difference between Pretest and Follow-up by Condition and Emotional Neglect History

Measure	EMI	EMA
All Participants ($N = 362$)		
DASS Depression	-.04	-.03
DASS Anxiety	.02	-.07*
DASS Stress	-.04	-.02
Perceived Stress	-.10 ⁺	-.08
PANAS Positive Affect	.21***	.15*
PANAS Negative Affect	.07	.11*
History of Emotional Neglect ($N = 134$)		
DASS Depression	-.09	.08
DASS Anxiety	-.01	-.04
DASS Stress	-.08	.03
Perceived Stress	-.14	-.06
PANAS Positive Affect	.16 ⁺	.19*
PANAS Negative Affect	.00	.18*
No History of Emotional Neglect ($N = 226$)		
DASS Depression	.08	-.14*
DASS Anxiety	.16 ⁺	-.10*
DASS Stress	.25*	-.08
Perceived Stress	-.06	-.10
PANAS Positive Affect	.25***	.10
PANAS Negative Affect	.12 ⁺	.04

Note. EMI = Ecological Momentary Intervention. EMA = Ecological Momentary Assessment. DASS = Depression Anxiety Stress Scale. Values are estimated coefficients from linear mixed model analyses reflecting change over time within groups. Negative values indicate greater marginal means at pretest (i.e., decreases in marginal means over time). ⁺ $p < .10$ * $p < .05$ *** $p < .001$

Table 12

Completion Rates for Feasibility and Usability Measures

Measure	EMI	EMA
Posttest	160/179 participants (89.4%)	160/183 participants (87.4%)
Follow-up	163/179 participants (91.1%)	167/183 participants (91.3%)
Daily	22.5/28 daily surveys (80.4%)	23.0/28 daily surveys (82.1%)

Table 13

Means, Standard Deviations, Independent t-tests, and Between-group Effect Sizes (Cohen's D) for Expectancy (D1) and Acceptability (T2) Measures

Item	EMI	EMA	<i>t</i>	<i>d</i>
How logical did this type of program seem to you?	D1: 83.17 (16.36) T2: 74.00 (19.18)	D1: 80.73 (16.45) T2: 61.55 (23.75)	1.33 5.03***	0.15 0.58
How successful did you feel this program was in decreasing stress?	D1: 67.64 (17.31) T2: 57.81 (22.68)	D1: 62.31 (19.71) T2: 40.35 (25.11)	2.55* 6.38***	0.29 0.73
How confident are you in recommending this treatment to a friend who has high stress?	D1: 67.30 (19.66) T2: 60.97 (25.11)	D1: 62.34 (23.12) T2: 40.90 (26.81)	2.04* 6.68***	0.23 0.77
How important is working on this problem for you?	D1: 82.11 (19.22) 59.42 (22.35)	D1: 81.09 (21.89) 46.24 (27.29)	0.44 4.57***	0.05 0.53
How much did you think your assigned intervention... was interesting?				
was useful?	61.64 (21.52)	43.40 (26.48)	6.54***	0.76
conveyed new information?	57.34 (23.93)	39.26 (25.46)	6.33***	0.73
clarified any misunderstandings?	56.88 (25.21)	38.02 (25.77)	6.30***	0.74
was easy to understand?	85.97 (17.26)	77.75 (24.17)	3.42***	0.39
was satisfactory?	66.31 (21.00)	51.09 (27.61)	5.29***	0.62
was easy to use?	83.09 (18.80)	82.26 (22.67)	0.35	0.04
was likeable?	65.07 (22.61)	56.00 (28.16)	3.05*	0.36
was potentially useful if more content were included?	70.01 (21.23)	72.55 (23.49)	-0.97	-0.11
was helpful in reducing distress?	60.18 (23.28)	37.88 (26.78)	7.70***	0.89
was helpful in increasing coping skills?	67.93 (21.04)	44.82 (28.40)	8.03***	0.92
How helpful did you find the following elements of this program?: Videos from Dr. Patricia Frazier	3.19 (1.13)	2.51 (1.09)	5.39***	0.61
The mobile application	3.69 (1.17)	2.96 (1.33)	5.16***	0.58
Written exercises	2.97 (1.14)	—	—	—
Motivational messages	3.61 (1.15)	—	—	—
Reminder messages to view mobile application	3.87 (1.20)	—	—	—

Note. D1 = Day 1 of daily assessments. T2 = Posttest (Time 2). EMI = Ecological Momentary Intervention. EMA = Ecological Momentary Assessment. *Ns* = 142-156. Positive *t* and *d* values indicate the EMI had larger means and negative *t* and *d* values

indicate the EMA had larger means. Items 1-15 range 0 (*not at all*) to 100 (*a great deal*). Items 16-21 range from 1 (*not helpful*) to 5 (*very helpful*) * $p < .05$ *** $p < .001$

Table 14

Means, Standard Deviations, Independent t-tests, and Between-group Effect Sizes (Cohen's D) for Ecological Momentary Intervention versus Web-based Intervention Comparison of Log 1 Character Counts

Question	EMI	WEB	<i>t</i>	<i>d</i>
What bothered you the most today?	64.51 (55.99)	195.81 (159.10)	-10.52	-0.98
What aspects of this situation are out of your control?	49.18 (41.68)	141.95 (79.85)	-13.69	-1.30
What aspects of this situation can you control?	59.31 (48.16)	147.97 (91.02)	-11.46	-1.09
Looking at the things you can control, are there specific actions you can take?	68.74 (56.03)	240.95 (175.20)	-12.09	-1.14
What has changed about the stressor as a result of the action you have taken?	45.20 (45.59)	147.48 (95.53)	-12.11	-1.18

Note. EMI = Ecological Momentary Intervention. WEB = Web-based intervention.

EMI *Ns* = 143-175; WEB *Ns* = 278-288. Positive *t* and *d* values indicate the EMI had larger means and negative *t* and *d* values indicate the EMA had larger means. ****p* < .001

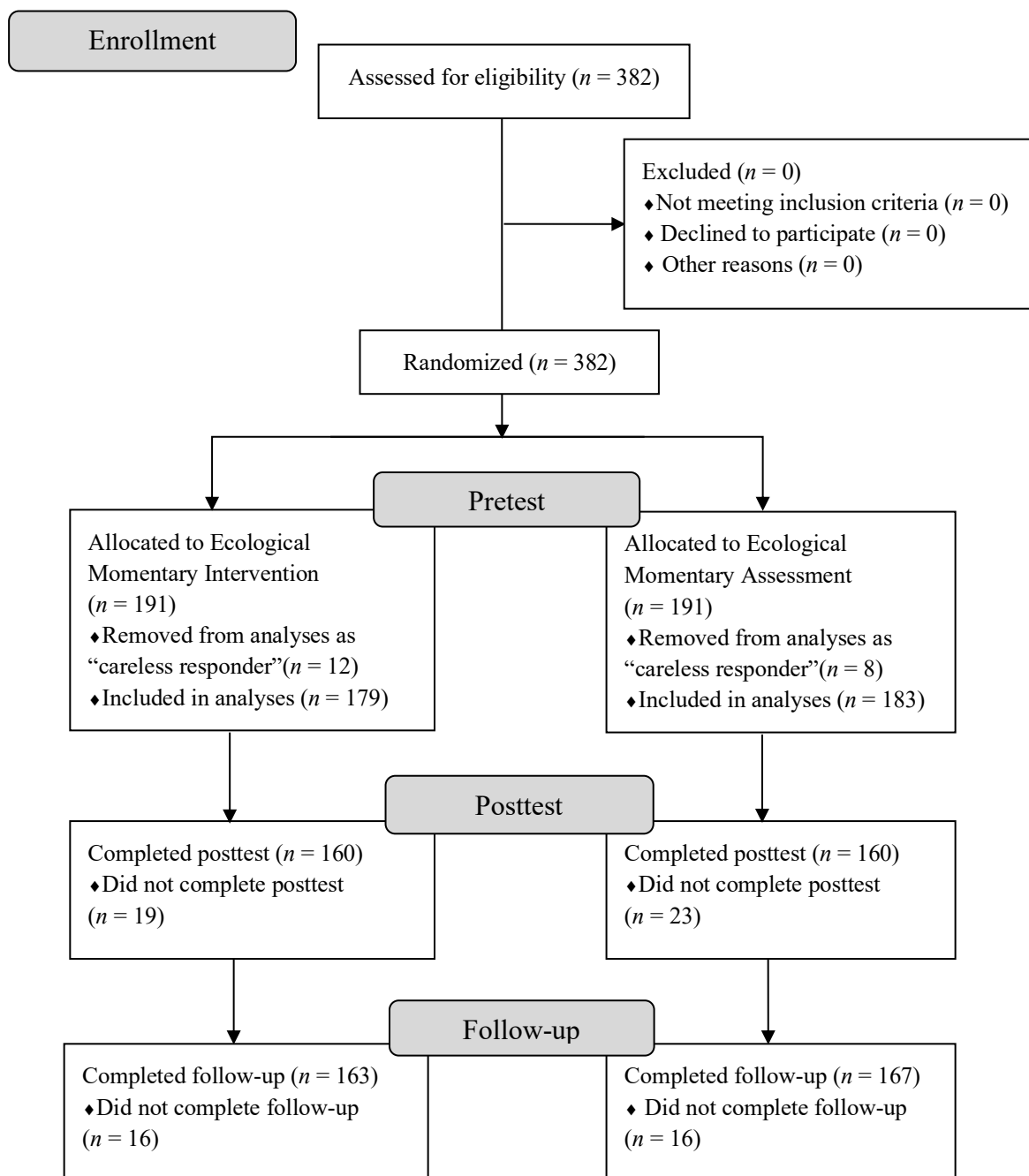


Figure 1. Consolidated standards of reporting trials (CONSORT) diagram.

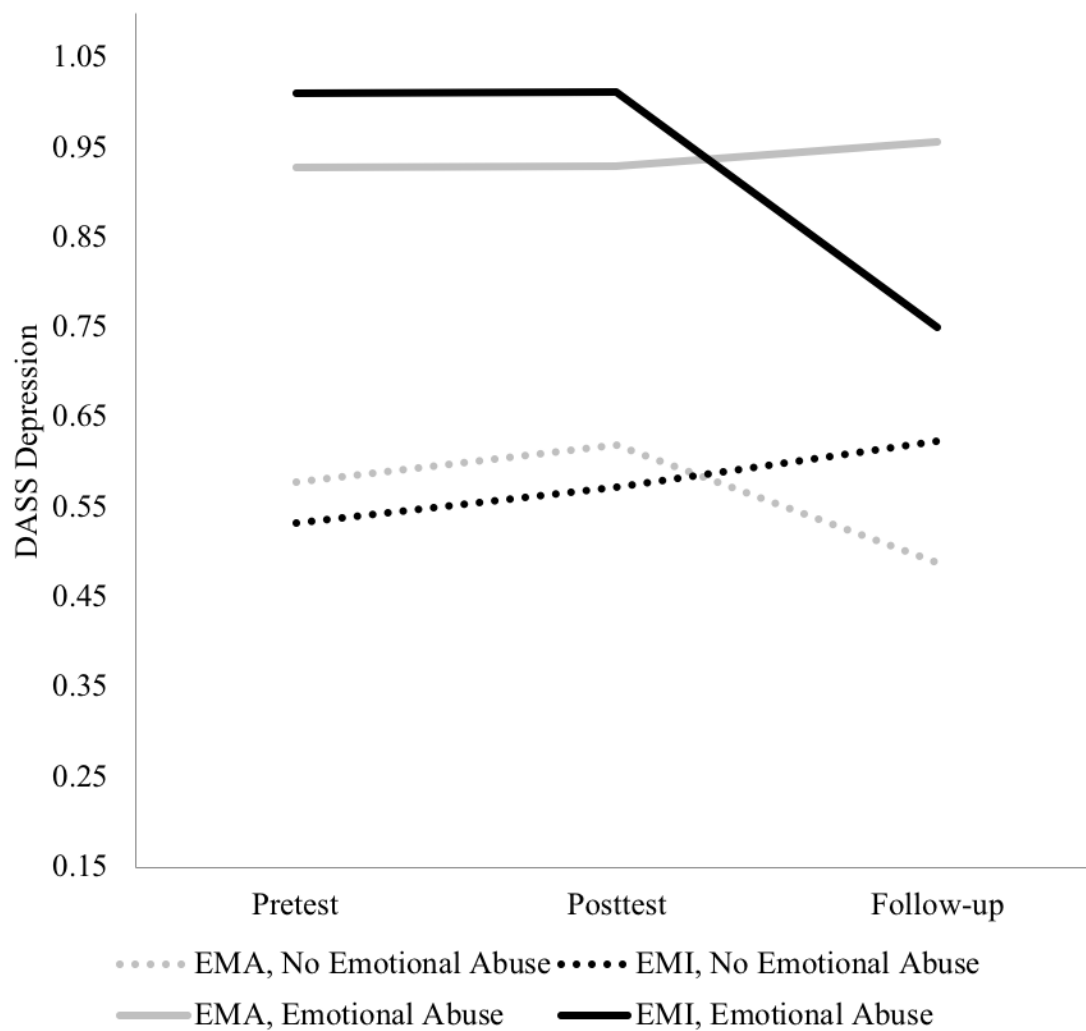


Figure 2. Depression Anxiety Stress Scale (DASS)—Depression subscale Linear Mixed Model least square means estimates at pretest, posttest, and follow-up.

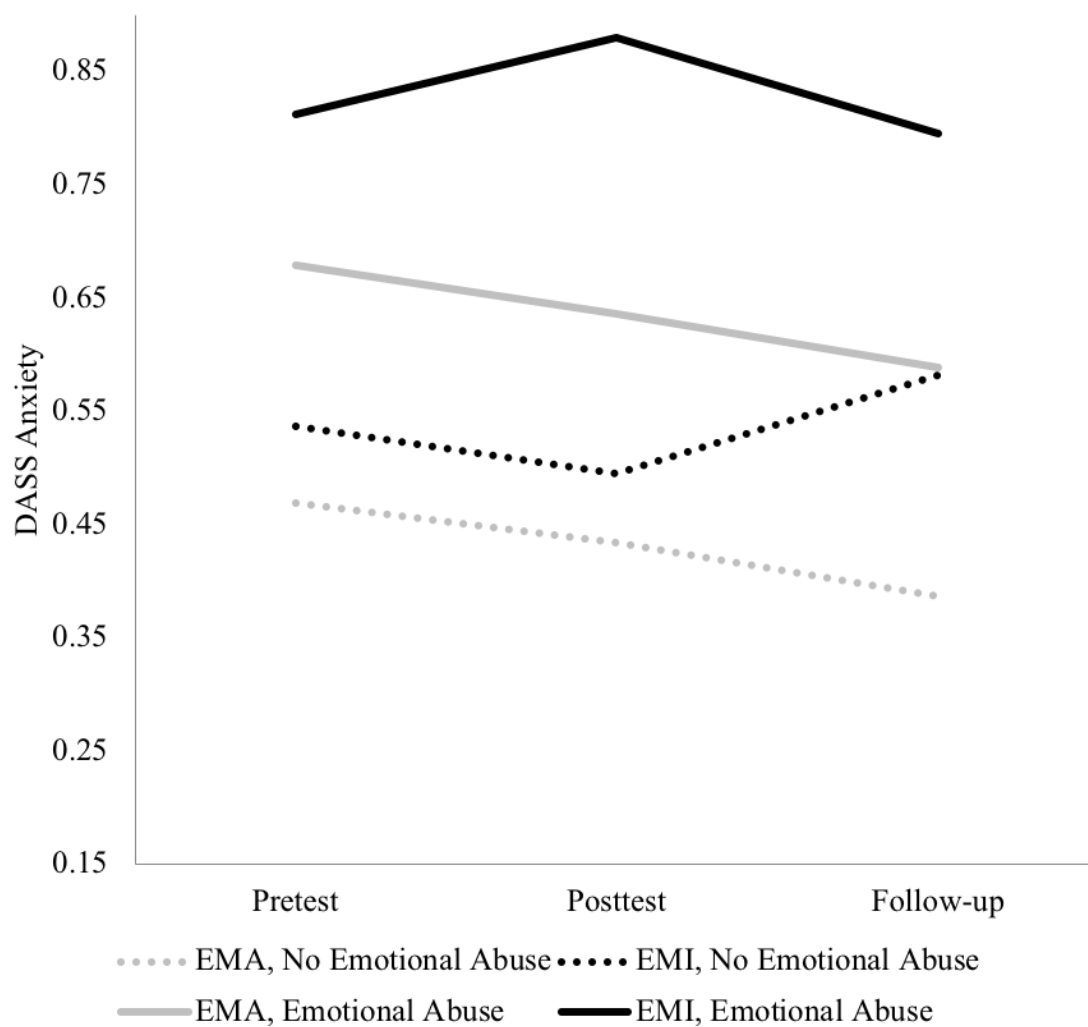


Figure 3. Depression Anxiety Stress Scale (DASS)—Anxiety subscale Linear Mixed Model least square means estimates at pretest, posttest, and follow-up.

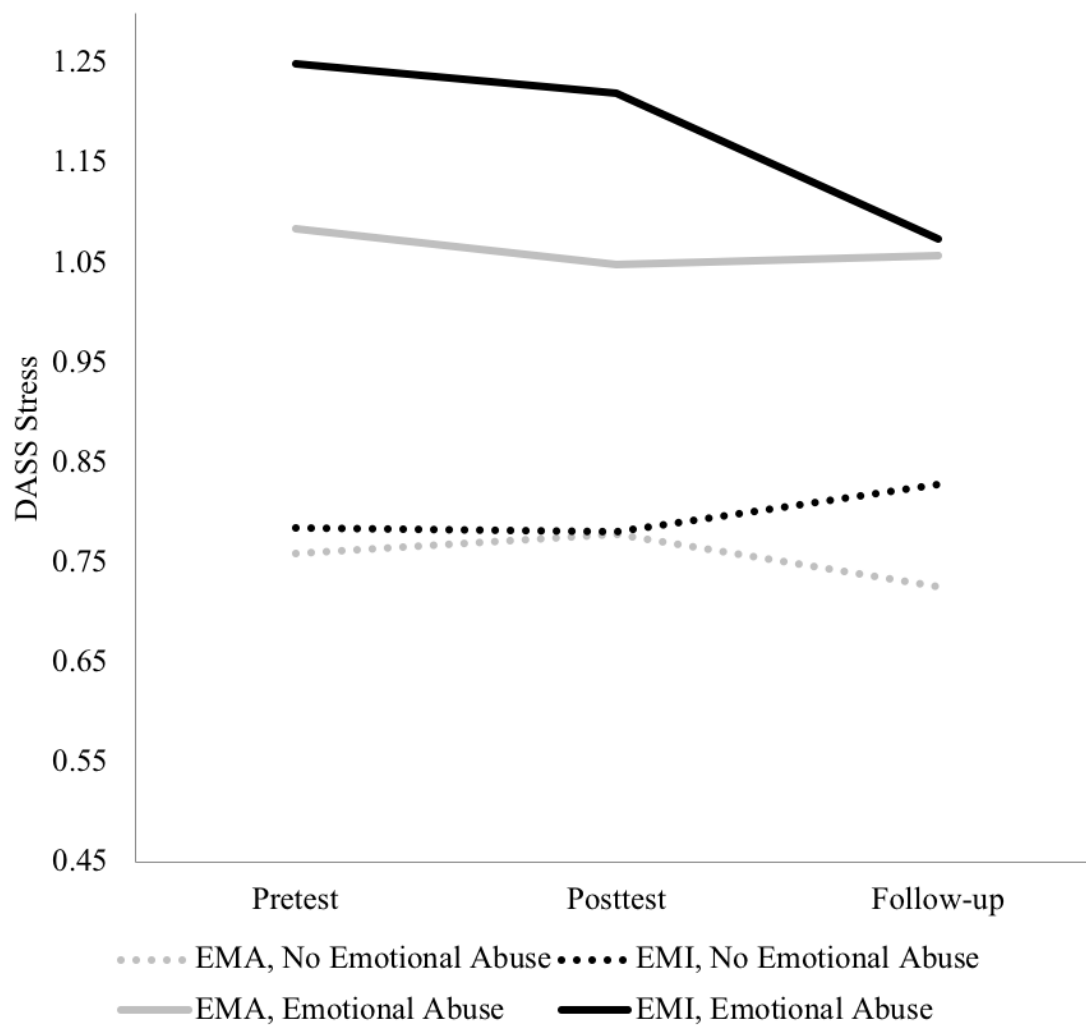


Figure 4. Depression Anxiety Stress Scale (DASS)—Stress subscale Linear Mixed Model least square means estimates at pretest, posttest, and follow-up.

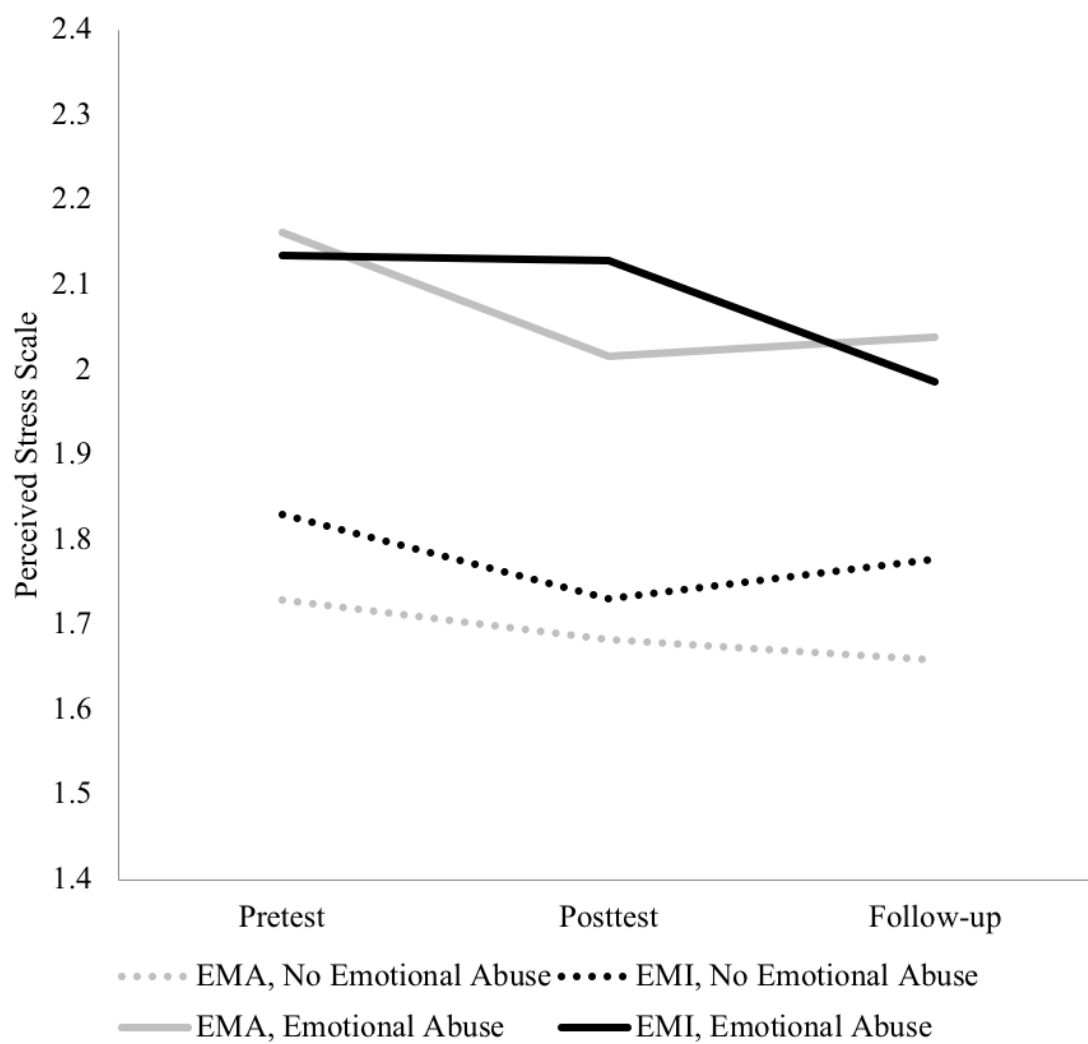


Figure 5. Perceived Stress Scale Linear Mixed Model least square means estimates at pretest, posttest, and follow-up.

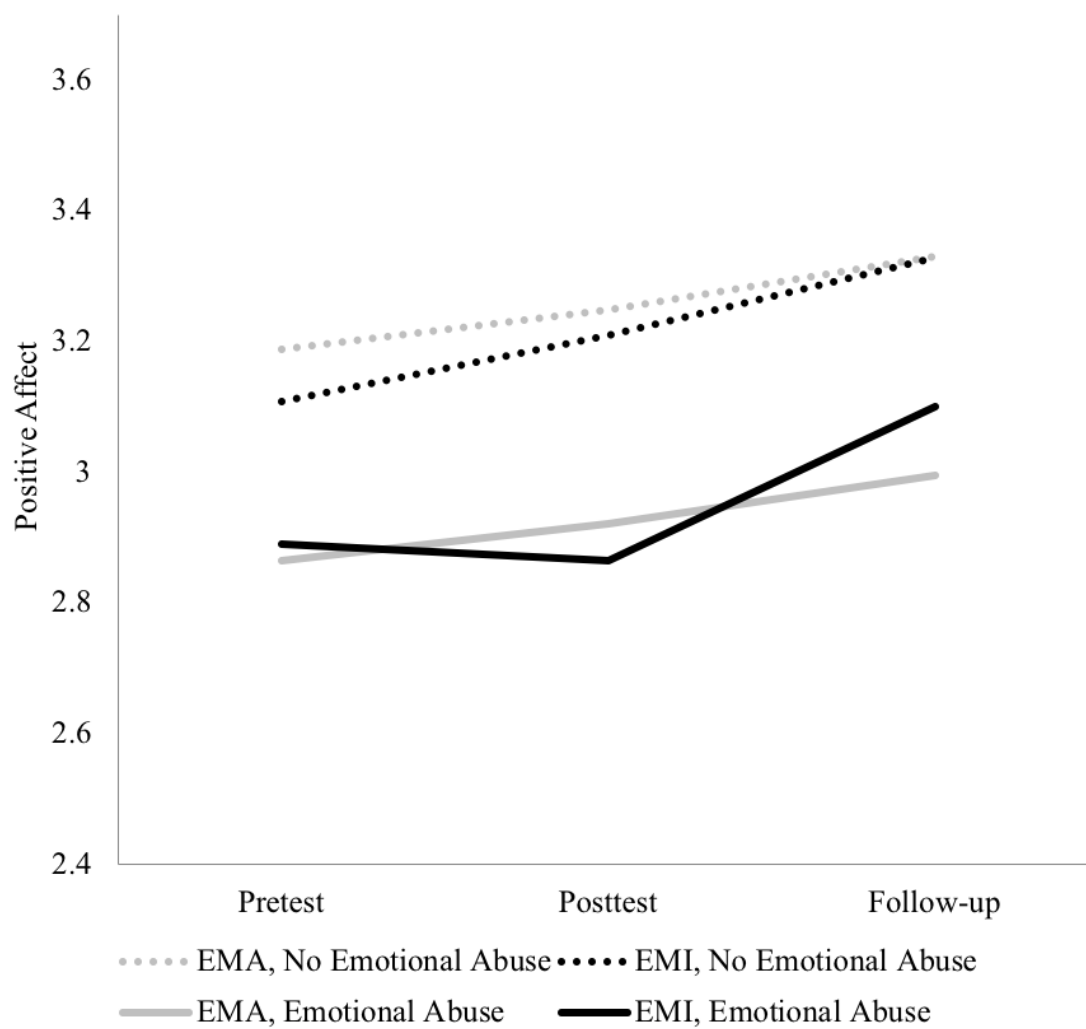


Figure 6. Positive and Negative Affect Scale—Positive Affect subscale Linear Mixed Model least square means estimates at pretest, posttest, and follow-up.

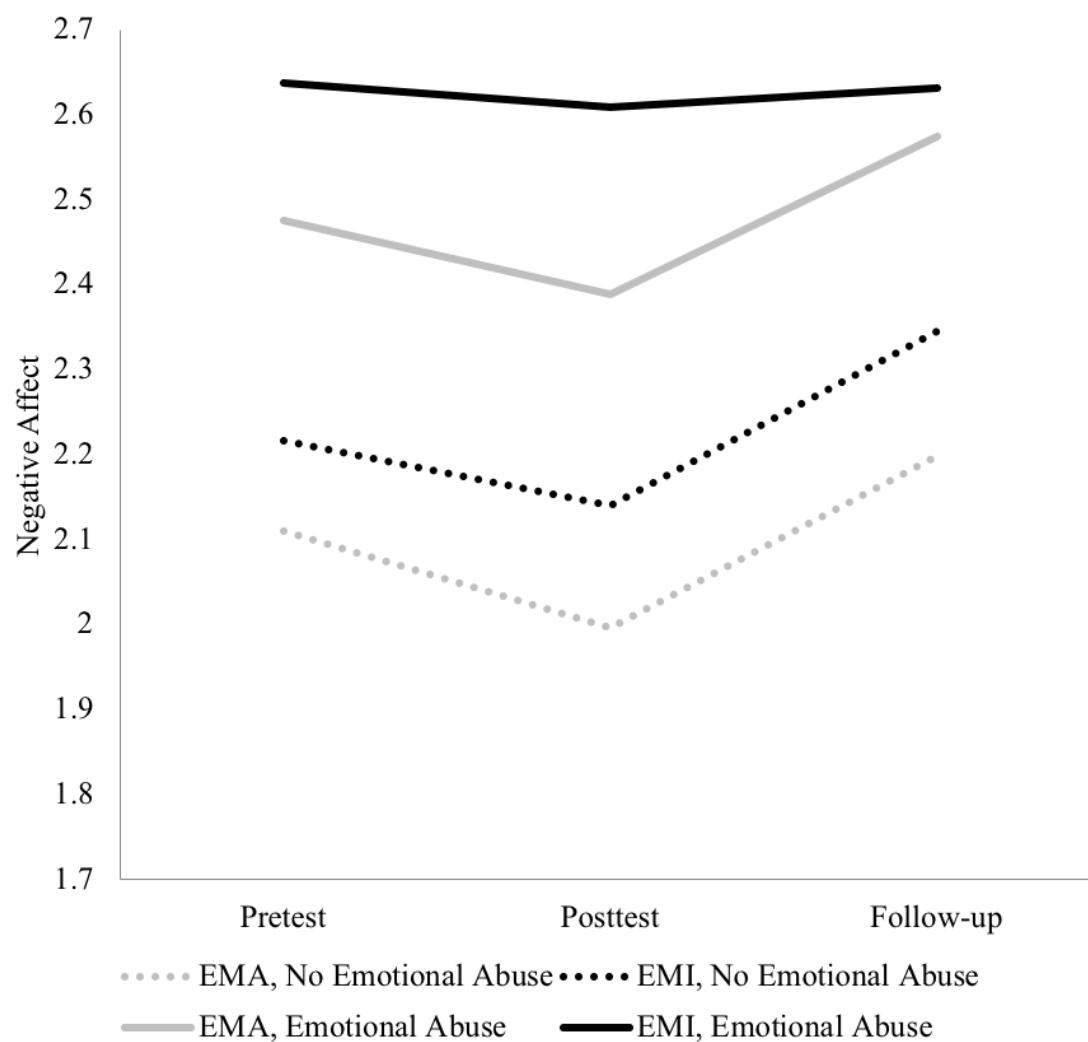


Figure 7. Positive and Negative Affect Scale—Negative Affect subscale Linear Mixed Model least square means estimates at pretest, posttest, and follow-up.

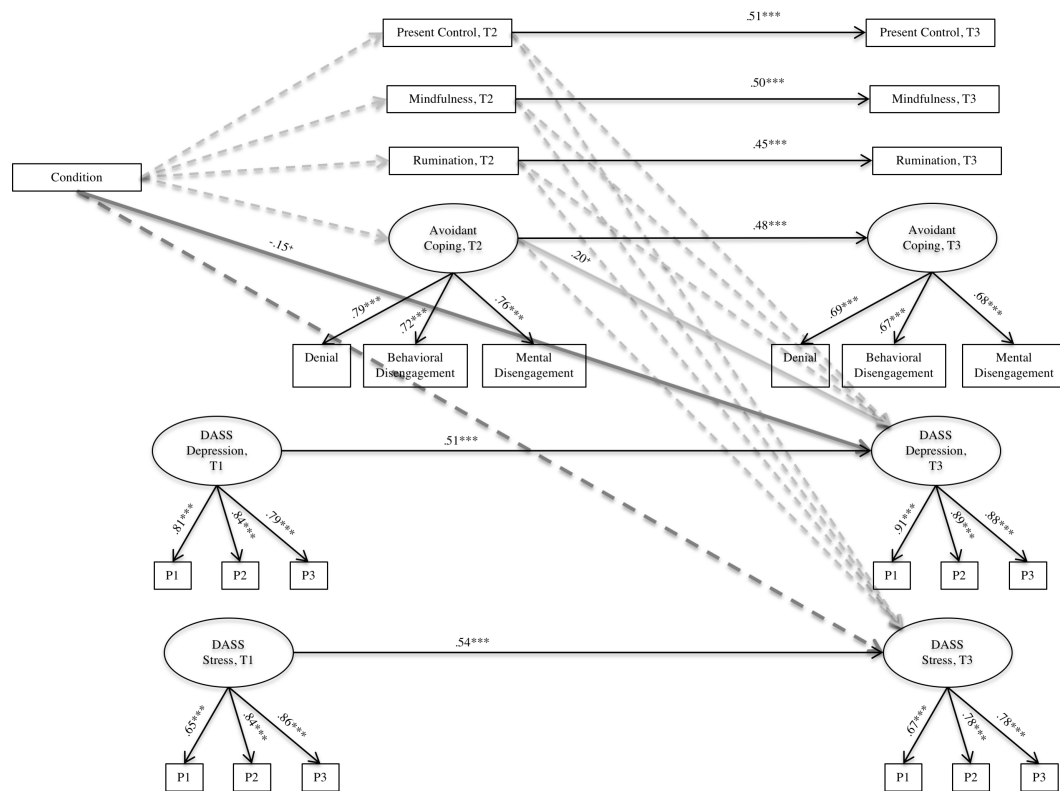


Figure 8. Structural equation model assessing mediators of the relations between condition (0 = ecological momentary assessment; 1 = ecological momentary intervention) and distress for participants with a history of emotional abuse. Values are standardized coefficients. Residuals of exogenous variables, variables measured at the same time point, and indicators across time points were all significantly correlated (not depicted in figure). $^+|\beta|s$ for T3 coping and distress variables = .27-.78 ($|\beta|s$ = .11-.64). $p < .10$ $^*p < .05$ $***p < .001$

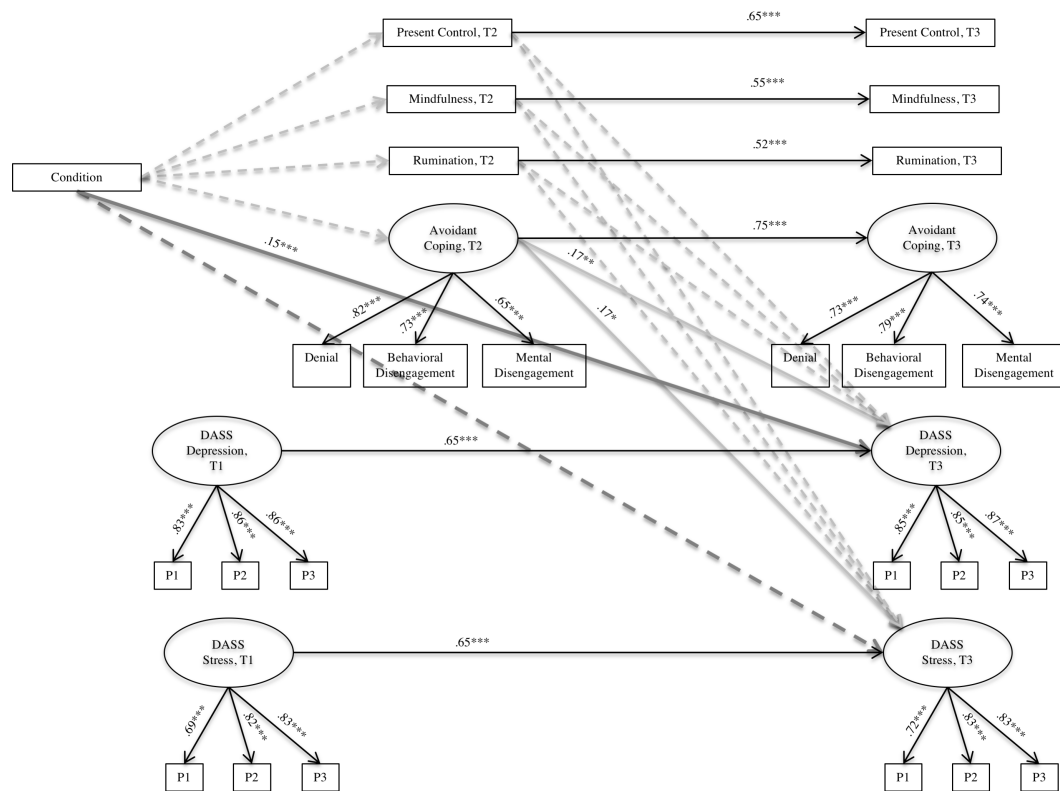


Figure 9. Structural equation model assessing mediators of the relations between condition (0 = ecological momentary assessment; 1 = ecological momentary intervention) and distress for participants without a history of emotional abuse. Values are standardized coefficients. Residuals of exogenous variables, variables measured at the same time point, and indicators across time points were all significantly correlated (not depicted in figure). $|\beta|$ s for T3 coping and distress variables = .22-.80 ($|B|$ s = .04-.36). $^+p < .10$ $^*p < .05$ $***p < .001$

Appendix A: Informed consent

You are invited to be in a research study on how stress may be reduced through a daily intervention. You were selected as a possible participant because you indicated an interest in receiving extra credit and learning about stress management through a Research Experience Program (REP) study or for extra credit in a Psychology class that is not part of the REP program. We ask that you read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by Professor Patricia Frazier and Viann Nguyen-Feng in the Psychology Department, University of Minnesota.

The purpose of this study is to gain a better understanding of ways to reduce stress.

If you agree to be in this study, you will be randomly assigned to one of two groups. We would ask you to do the following things:

- You will first be asked to complete a pretest survey online, which asks about past life events, stress, and current thoughts and feelings. This survey may take about 20-30 minutes.
- You will then be asked to complete two brief surveys every day for 14 days. Each survey will be sent to you via an application on your iPhone or Android smartphone and in a link to your UMN email address. Before completing your first daily survey, you will read the instructions on how to use the smartphone application or your web browser to complete your daily surveys. The morning surveys take ~2 minutes each and ask about your sleep and mood. The evening surveys take 3-8 minutes each and ask about daily events and mood. They may also include an activity to help manage your stress, depending on your group assignment. Completing these 2 surveys daily for 2 weeks may take about 140 minutes total.
- After the 14 days of daily surveys, you will be asked to complete a posttest survey similar to the pretest survey containing questions about life events, stress, and current thoughts and feelings. This may take about 20-30 minutes.
- Approximately three weeks after the posttest, you will be asked to complete a follow-up survey similar to the posttest survey containing questions about life events, stress, and current thoughts and feelings. This may take about 20-30 minutes.

During the 14 days, we may also send you a motivational message every day via the smartphone application, depending on your group assignment. Altogether, this study may take up to 260 minutes (i.e., about 4.5 hours). In addition, by agreeing to participate, you give permission to access information from your University records, such as grade point average and academic progress.

Risks and Benefits of Being in the Study:

Participants will be asked to think about and answer questions about stress. Participants may experience temporary discomfort when thinking about their stressful experiences. This could include emotional distress or personal discomfort regarding questions about specific life circumstances. Some of the questions regarding stress are personal in nature, but we do not anticipate any substantial risk.

Participants may be exposed to information about stress through the videos and exercises. The aim of this study is to enhance skills for coping with stress. The information is unlikely to produce harm.

Participation in the research may mean a loss of confidentiality. The records of this study will be kept private. In any sort of report we might publish, we will not include any information that will make it possible to identify a subject. Research records will be stored securely and only researchers will have access to the records. Once the data collection has been completed, the identifying information along with any link to personal data will be destroyed. Study data will be encrypted according to current University policy for protection of confidentiality.

Compensation

You will receive extra credit points according to the policies specified on the REP website at the standard rate of 1 point for 30 minutes of time spent for a maximum of 9 points.

Voluntary Nature of the Study:

Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University of Minnesota. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

Contacts and Questions:

The researchers conducting this study are Patricia Frazier, PhD and Viann Nguyen-Feng, PhD candidate. You may ask any questions you have now. If you have questions later, you are encouraged to contact them. Professor Frazier's phone number is 612-625-6863 and her email is pfraz@umn.edu. Viann Nguyen-Feng's phone number is 612-625-2818 and her email is viann@umn.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher(s), you are encouraged to contact the Research Subjects' Advocate Line, D528 Mayo, 420 Delaware St. Southeast, Minneapolis, Minnesota 55455; (612) 625-1650.

If you experience any distress as a result of participating in this study, you are encouraged to contact Student Counseling Services, 128 Pleasant Street SE, 340 Appleby Hall, Minneapolis, MN or 199 Coffey Hall, St. Paul, MN, Phone: 612-624-3323, which provides free services to University students. Their web address is <http://counseling.umn.edu/>.

Other resources on campus are The Aurora Center, which provides free and confidential crisis intervention and advocacy services to victim/survivors of sexual assault, relationship violence, and stalking. Their address is 407 Boynton, 410 Church Street SE, Minneapolis, MN 55455. Their web site address is <http://www1.umn.edu/aurora/> and their phone numbers are as follows: Business line: 612-626-2929, TTY line: 612-626-4279, Crisis line (24 hours): 612-626-9111.

A final resource is the Boynton Health Services Mental Health Clinic. Their services also are free if you are registered for at least 6 credits. Their web site is <http://www.bhs.umn.edu/east-bank-clinic/mental-health-services.htm> and they are located at 410 Church Street SE, Minneapolis, MN 55455. The phone number for appointments is (612) 625-8400. Their web site has additional referral information and crisis resources.

You may print a copy of this information to keep for your records.

Statement of Consent:

I have read the above description of the study, and I agree to participate.

You must click "Yes" to continue. If you do not wish to continue, please exit the survey. Thank you.

Appendix B: Measures

Asterisk (*) indicates selected item used for daily measures.

Baseline characteristics

1. What is your age? (in years)
2. What year are you in school?
 - a. Freshman
 - b. Sophomore
 - c. Junior
 - d. Senior
 - e. Grad student
 - f. Other
3. Are you an international student?
 - a. Yes
 - b. No
4. What's your current employment status?
 - a. I have a full-time job
 - b. I have a part-time job
 - c. I am not currently working
5. What is your sex?
 - a. Male
 - b. Female
 - c. Other (please describe)
6. What is your current relationship status?
 - a. Single
 - b. Dating
 - c. In a committed relationship and not living together
 - d. In a committed relationship and cohabitating
 - e. Married
 - f. Divorced
 - g. Separated
 - h. Widowed
 - i. Other
7. What best describes your sexual orientation?
 - a. Heterosexual or Straight
 - b. Gay, Lesbian, or Queer
 - c. Pansexual or Bisexual
 - d. Other, please describe (e.g., fluid, demisexual, asexual)

8. How do you describe your race/ethnicity? (Select one or more)
- European American or White
 - African American or Black
 - Asian American or Asian
 - Hispanic or Latinx
 - Native American, Hawaiian Native, or Alaskan Native
 - Middle Eastern or Arab American
 - Other (please describe)

Other Coping (beginning on second evening)

On the first evening, you watched a video that taught different skills and presented different aspects of the stress management program. Please select the options that apply to you today. (True/False)

I used deep breathing to calm down

I used the stop sign metaphor

I re-watched the video(s) of Dr. Frazier

I read the written exercises on STOP and present control on the app

I listened to a mindfulness exercise audio on the app

Positive and Negative Affect Schedule (Watson, Clark, & Tellegen, 1988) /

International Positive and Negative Affect Schedule Short Form (Thompson, 2007)

This scale consists of a number of words that describe different feelings and emotions.

Read each item and then select the number from the scale below next to each word.

Indicate the extent you have felt this way over the past week. / For Daily Assessments:

Indicate to what extent you feel this way right now, that is, at the present moment

1 = very slightly or not at all

2 = a little

3 = moderately

4 = quite a bit

5 = extremely

- Interested
- Distressed
- Excited
- *Upset
- Strong
- Guilty
- Scared
- *Hostile
- Enthusiastic

10. Proud
11. Irritable
12. *Alert
13. *Ashamed
14. *Inspired
15. *Nervous
16. *Determined
17. *Attentive
18. Jittery
19. *Active
20. *Afraid

Depression Anxiety and Stress Scale, 21 items (Lovibond & Lovibond, 1995)

For each statement below, please select the number in the column that best represents how you have been feeling in the last week.

- 1 = Did not apply to me at all
- 2 = Applied to me to some degree or some of the time
- 3 = Applied to me a considerable degree or a good part of the time
- 4 = Applied to me very much or most of the time

1. I found it hard to wind down
2. I was aware of dryness of my mouth
3. I couldn't seem to experience any positive feeling at all
4. I experienced breathing difficulty (e.g., excessively rapid breathing, breathlessness in the absence of physical exertion)
5. I found it difficult to work up the initiative to do things
6. I tended to over-react to situations
7. I experienced trembling (e.g., in the hands)
8. I felt that I was using a lot of nervous energy
9. I was worried about situations in which I might panic and make a fool of myself
10. I felt that I had nothing to look forward to
11. I found myself getting agitated
12. I found it difficult to relax
13. I felt down-hearted and blue
14. I was intolerant of anything that kept me from getting on with what I was doing
15. I felt I was close to panic
16. I was unable to become enthusiastic about anything.
17. I felt I wasn't worth much as a person
18. I felt that I was rather touchy
19. I was aware of the action of my heart in the absence of physical exertion (e.g., sense of heart rate increase, heart missing a beat)
20. I felt scared without any good reason.
21. I felt that life was meaningless

Perceived Stress Scale (Cohen, Kamarek, & Mermelstein, 1983)

The questions below ask you about your feelings and thoughts during the last week. In each case, please indicate with a check how often you felt or thought a certain way.

0 = never

1 = almost never

2 = sometimes

3 = fairly often

4 = very often

In the last week, how often have you...

1. been upset because of something that happened unexpectedly?
2. felt that you were unable to control the important things in your life?
3. felt nervous and "stressed"?
4. felt confident about your ability to handle your personal problems?
5. felt that things were going your way?
6. found that you could not cope with all the things that you had to do?
7. been able to control irritations in your life?
8. felt that you were on top of things?
9. been angered because of things that were outside of your control?
10. felt difficulties were piling up so high that you could not overcome them?

Stressors (adapted from Baker, Nguyen-Feng, Nilakanta, & Frazier, 2018; Nguyen-Feng, Baker, Merians, & Frazier, 2017a)

Think back to a time in the past two weeks when you experienced something stressful. Briefly describe the situation here.

Think back to after you completed your last evening survey. Check any of the following stressors that you experienced since completing yesterday's survey:

- Too much school work (e.g., major assignment or deadline, large workload)
 - Preparing for/taking tests, exams, or quizzes
 - Difficulties balancing school and other responsibilities
 - Preparing for your future/career path (e.g., filling out applications, finding/losing a job, not getting into major)
 - Issues at/with your job
 - Receiving a lower grade than you want
 - Financial problems (e.g., rent or bills due, being broke)
 - Interpersonal conflict/problem/argument/disagreement (e.g., with prior/current romantic partner(s), roommate, family member, boss)
 - Health-related issue of self or family member
 - Other (please describe):
-

What bothered you the most today? It can be something on the stressor checklist or something else. Briefly describe the situation here.

How much did it bother you?

0 = not at all; 10 = very, very much

Pemberton Happiness Index (adapted from Hervás & Vázquez, 2013)

Using the following scale from 0 to 10, with 0 being total disagreement and 10 being total agreement, please rate the extent to which you agree with the following statements **right now**.

Totally disagree 0 1 2 3 4 5 6 7 8 9 10 Totally agree

1. I am very satisfied with my life
2. I have the energy to accomplish my daily tasks
3. I think my life is useful and worthwhile
4. I am satisfied with myself
5. My life is full of learning experiences and challenges that make me grow
6. I feel very connected to the people around me
7. I feel able to solve the majority of my daily problems
8. I think that I can be myself on the important things
9. I enjoy a lot of little things every day
10. I have a lot of bad moments in my daily life
11. I think that I live in a society that lets me fully realize my potential

Please mark which of the following happened to you today (YES / NO):

1. Something I did made me proud
2. At times, I felt overwhelmed
3. I did something fun with someone
4. I was bored for a lot of the time
5. I did something I really enjoy doing
6. I was worried about personal matters
7. I learned something interesting
8. I gave myself a treat
9. Things happened that made me really angry
- 10.** I felt disrespected by someone

If participants do not list a stressor on days without a written exercise: What's the best thing that happened to you today? It can be something on the checklist above or something else. Briefly describe the situation here.

In regards to the best thing that happened to you today, how much happiness did it bring you?

0 = not at all; 10 = very, very much

Top Problems Measure (adapted from Weisz et al., 2011)

What problems in your life are you most concerned with? Please list them below.

How big of a problem is this for you?

0 = not at all; 10 = very, very much

Which one of these is the biggest problem right now?

Which one of these is giving you the most trouble right now?

COPE Revised (adapted from Zuckerman & Gagne, 2003)

We are interested in how people respond when they confront difficult or stressful events in their lives. There are lots of ways to try to deal with stress. This questionnaire asks you to indicate what you generally do and feel, when you experience stressful events. Obviously, different events bring out somewhat different responses, but think about what you usually do when you are under a lot of stress. / Please answer these questions with regard to what you did TODAY to handle the event you described above. / We are interested in how people respond when they confront difficult or stressors in their lives. There are lots of ways to try to deal with stress. This questionnaire asks you to indicate what you generally did and felt over the past 14 days when you experienced stressors. Obviously, different events bring out somewhat different responses, but think about what you usually did when you were under a lot of stress.

1 = I didn't do this at all

2 = I did this a little bit

3 = I did this a medium amount

4 = I did this a lot

1. *I blamed myself
2. I realized I brought the problem on myself
3. I criticized or lectured myself
4. I saw that I was at the root of the problem
5. *I just thought about my problem constantly
6. *I returned in my head again and again to what was troubling me
7. *I relived the problem by dwelling on it all the time
8. *I brooded over my problem non-stop
9. I took time to express my emotions
10. I let my emotions show
11. *I tried to let out my feelings
12. I allowed myself to show how I felt about things
13. *I discussed my feelings with someone
14. *I tried to get emotional support from friends or relatives
15. *I talked to someone about how I felt
16. *I talked to someone to find out more about the situation

17. I concentrated my efforts on doing something about it
18. *I took additional action to try to get rid of the problem
19. I took direct action to get around the problem
20. I did what has to be done, one step at a time
21. I made a plan of action
22. *I tried to come up with a strategy about what to do
23. I thought hard about what steps to take
24. *I tried hard to prevent other things from interfering with my efforts at dealing with this
25. I tried to be optimistic in spite of what happened
26. I worked on feeling positive no matter what
27. *I worked on staying positive even when things looked bad
28. I got used to the idea that it happened
29. *I accepted the reality of the fact that it happened
30. I tried to see it in a different light, to make it seem more positive
31. *I looked for something good in what was happening
32. *I tried to identify something else I cared about
33. I said to myself "this isn't real"
34. I refused to believe that it had happened
35. *I pretended that it hadn't really happened
36. *I admitted to myself that I can't deal with it, and quit trying
37. I gave up the attempt to get what I want
38. I blamed someone or something for what happened to me
39. *I accused someone of causing my misfortune
40. *I tried to forget the whole thing

Present Control over Stressful Events Scale, Present Control subscale (adapted from Frazier et al., 2011a)

Using the following scale, please respond with regard to how you handled the stressful event you described above. / Using the following scale, please respond with regard to how you felt today about the event you described above.

- 1 = strong disagree
 2 = disagree somewhat
 3 = agree somewhat
 4 = strongly agree

1. There wasn't much I could do to help myself feel better about the situation.
2. *How I dealt with the situation was under my control.
3. I didn't have much control over my emotional reactions to the situation.
4. If I was upset about the situation, I could find a way to feel better.
5. *I had control over my reactions to the situation.
6. There wasn't much I can do to keep the situation from affecting me.
7. *I had control over how I thought about the situation.

8. My reaction to the situation was not under my control.
9. *(Daily only) I tried to focus on things I had control over.

Five Facet Mindfulness Questionnaire, Non-reactivity Subscale (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006)

Please rate each of the following statements using the scale provided. Select what best describes your own opinion of what is/was generally true for you / generally true today of how you handled the event you described above.

- 1 = never or very rarely true
 2 = rarely true
 3 = sometimes true
 4 = often true
 5 = very often or always true

1. I perceive my feelings and emotions without having to react to them
2. I watch my feelings without getting lost in them
3. *When I have distressing thoughts or image, I “step back” and am aware of the thought or image without getting taken over by them
4. *In difficult situations, I can pause without immediately reacting / I paused without immediately reacting
5. When I have distressing thoughts or images, I feel calm soon after
6. When I have distressing thoughts or images, I am able just to notice them without reacting
7. *When I have distressing thoughts or images, I just notice them and let them go / I just noticed thoughts or images and let them go.

Childhood Trauma Questionnaire—Short Form (Bernstein et al., 2003)

The following questions ask about some of your experiences growing up as a child and a teenager. Although these questions are of a personal nature, please try to answer as honestly as you can. For each question, select the response that best describes how you feel.

When I was growing up...

- 1 = never true
 2 = rarely true
 3 = sometimes true
 4 = often true
 5 = very often true

1. I didn't have enough to eat.
2. I knew that there was someone to take care of me and protect me.
3. People in my family called me things like "stupid," "lazy," or "ugly."
4. My parents were too drunk or high to take care of the family.
5. There was someone in my family who helped me feel that I was important or special.
6. I had to wear dirty clothes.
7. I felt loved.
8. I thought that my parents wished I had never been born.
9. I got hit so hard by someone in my family that I had to see a doctor or go to the hospital.
10. There was nothing I wanted to change about my family.
11. People in my family hit me so hard that it left me with bruises or marks.
12. I was punished with a belt, a board, a cord, or some other hard object.
13. People in my family looked out for each other.
14. People in my family said hurtful or insulting things to me.
15. I believe that I was physically abused.
16. I had the perfect childhood.
17. I got hit or beaten so badly that it was noticed by someone like a teacher, neighbor, or doctor.
18. I felt that someone in my family hated me.
19. People in my family felt close to each other.
20. Someone tried to touch me in a sexual way or tried to make me touch them.
21. I had the best family in the world.
22. Someone threatened to hurt me or tell lies about me unless I did something sexual with them.
23. Someone tried to make me do sexual things or watch sexual things.
24. Someone molested me.
25. I believe that I was emotionally abused.
26. There was someone to take me to the doctor if I needed it.
27. I believe that I was sexually abused.
28. My family was a source of strength and support.

Traumatic Life Events Questionnaire (Kubany et al., 2000)

The next questions will ask you to indicate whether you have experienced a variety of stressful events. The events described below are far more common than many people realize and can affect a person's mental health or later quality of life. Please indicate whether you have experienced any of these events with a "yes" or "no" answer.

1. A natural disaster (flood, hurricane, earthquake, etc.).
2. A motor vehicle accident for which you received medical attention or that badly injured or killed someone.
3. Another kind of accident in which you or someone else was badly hurt.
4. Lived, worked, or had military service in a war zone.
5. The sudden and unexpected death of a close friend or loved one.
6. A loved one surviving a life-threatening or permanently disabling accident, assault, or illness.
7. A life-threatening illness.
8. Robbed or been present during a robbery in which the robber(s) used or displayed a weapon.
9. Hit or beaten up and badly hurt by a stranger or someone you didn't know very well.
10. Seen a stranger (or someone you didn't know very well) attack or beat up someone and seriously injure or kill him.
11. Someone threatened to kill you or cause you serious physical harm.
12. While growing up: physically punished in a way that resulted in bruises, burns, cuts, or broken bones.
13. While growing up: saw or heard family violence.
14. Slapped, punched, kicked, beaten up, or otherwise physically hurt by your spouse (or former spouse), a boyfriend, or girlfriend.
15. Before your 13th birthday: someone who was at least 5 years older than you touched or fondled your body in a sexual way or made you touch or fondle his or her body in a sexual way?
16. Before your 13th birthday: someone close to your age touched sexual parts of your body or made you touch sexual parts of his or her body against your will or without your consent?
17. After your 13th birthday and before your 18th birthday: someone touched sexual parts of your body or made you touch sexual parts of his or her body against your will or without your consent?
18. After your 18th birthday: someone touched sexual parts of your body or made you touch sexual parts of his or her body against your will or without your consent?
19. Subjected to uninvited or unwanted sexual attention.
20. Someone stalked you (in other words, followed you or kept track of your activities), causing you to feel intimidated or concerned for your safety.
21. You or an intimate partner had a miscarriage.
22. You or an intimate partner had an abortion.
23. You experienced (or saw) any other events that were life threatening, caused serious injury, or were highly disturbing or distressing.

Expectancy Survey (adapted from Borkovec & Nau, 1972; Turner-Stokes, 2009)

Please rate the following items on the following scale:

0 = not at all; 100 = a great deal

1. How logical does this type of program seem to you? / How logical did this type of program seem to you?
2. How successful do you feel this program would be in decreasing stress? / How successful did you feel this program was in decreasing stress?
3. How confident would you be in recommending this treatment to a friend who had high stress? / How confident are you in recommending this treatment to a friend who has high stress?
4. What are the main problems that you would like to work on with this program?
5. How important is working on this problem for you?
0 = not at all; 100 = a great deal
6. What do you expect to be able to achieve with this program?

Feedback Survey (adapted from Guarino, Acosta, Marsch, Xie, & Aponte-Melendez, 2016)

Please rate the following items on the following scale:

0 = not at all; 100 = a great deal

How much did you think your assigned intervention...

1. was interesting? Comment?
2. was useful? Comment?
3. conveyed new information? Comment?
4. clarified any misunderstandings? Comment?
5. was easy to understand? Comment?
6. was satisfactory? Comment?
7. was easy to use? Comment?
8. was likable? Comment?
9. was potentially useful if more content were included? Comment?
10. was helpful in reducing distress? Comment?
11. was helpful in increasing coping skills? Comment?

Please briefly provide answers to the following questions:

1. What are your general comments on the intervention?
2. What are your suggestions for improvement, if any?
3. What additional content areas for the application would you want in the future, if any?

Feedback Survey (adapted from Hintz, Frazier, & Meredith, 2015)

Pretest:

Please rate the following items on the following scale:

1 = not helpful; 5 = very helpful

How helpful do you anticipate the following elements of this program to be?

1. Videos from Dr. Patricia Frazier
2. Written exercises (e.g., exercises on present control, mindfulness logs)
3. Daily motivational messages delivered via the mobile application
4. Reminder messages to view mobile application
5. The mobile application (e.g., mindfulness audios, written exercises)

Posttest:

Please rate the following items on the following scale:

1 = not helpful; 5 = very helpful

How helpful did you find the following elements of this program?

1. Videos from Dr. Patricia Frazier
2. Written exercises (e.g., written exercises on present control and mindfulness)
3. Motivational messages
4. Reminder messages to view mobile application
5. The mobile application (e.g., notifications, mindfulness audios, written exercises)

If there was a particular area you found confusing or unhelpful, please explain below.

Motivated Strategies for Learning Questionnaire, Academic Self-efficacy subscale

(adapted from Pintrich, Smith, Garcia, & McKeachie, 1993)

Think of the class you're most worried about this semester. The following questions ask about your attitudes about that class. Remember, there are no right or wrong answers, just answer as accurately as possible.

1 = not at all true of me; 7 = very true of me

1. I believe I will receive an excellent grade in my class this semester.
2. I'm certain I can understand the most difficult material presented in the readings for my class.
3. I'm confident I can learn the basic concepts taught in my class.
4. I'm confident I can understand the most complex material presented by the instructor in my class.
5. I'm confident I can do an excellent job on the assignments and tests in my class.
6. I expect to do well in my class.
7. I'm certain I can master the skills being taught in my class.
8. Considering the difficulty of my course load, the professors, and my skills, I think I will do well my class.

Big Five Inventory (John & Srivastava, 1999)

How well do the following statements describe your personality?

1 = disagree strongly

- 2 = disagree a little
3 = neither agree nor disagree
4 = agree a little
5 = agree strongly

I see myself as someone who...

1. is talkative
2. tends to find fault with others
3. does a thorough job
4. is depressed, blue
5. is original, comes up with new ideas
6. is reserved
7. is helpful and unselfish with others
8. can be somewhat careless
9. is relaxed, handles stress well
10. is curious about many different things
11. is full of energy
12. starts quarrels with others
13. is a reliable worker
14. can be tense
15. is ingenious, a deep thinker
16. generate a lot of enthusiasm
17. has a forgiving nature
18. tends to be disorganized
19. worries a lot
20. has an active imagination
21. tends to be quiet
22. is generally trusting
23. tends to be lazy
24. is emotionally stable, not easily upset
25. is inventive
26. has an assertive personality
27. can be cold and aloof
28. perseveres until the task is finished
29. can be moody
30. values artistic, aesthetic experiences
31. is sometimes shy, inhibited
32. is considerate and kind to almost everyone
33. does things efficiently
34. remains calm in tense situations
35. prefers work that is routine
36. is outgoing, sociable
37. is sometimes rude to others
38. makes plans and follows through with them

- 39. gets nervous easily
- 40. likes to reflect, play with ideas
- 41. has few artistic interests
- 42. likes to cooperate with others
- 43. is easily distracted
- 44. is sophisticated in art, music, or literature

Sleep (pretest, posttest):

Pittsburgh Sleep Quality Index (adapted from Buysse, Reynolds, Monk, Berman, & Kupfer, 1989)

The following questions relate to your usual sleep habits during the past month **only**. Your answers should indicate the most accurate reply for the **majority** of days and nights in the past month.

- 1. During the past month, what time have you usually gone to bed at night? Bed time: _____
- 2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night? Number of minutes: _____
- 3. During the past month, what time have you usually gotten up in the morning? Getting up time: _____
- 4. During the past month, how many hours of **actual sleep** did you get at night? (This may be different than the number of hours you spent in bed.) Hours of sleep per night: _____

For each of the remaining questions, check the best response.

0 = Not during the past month

1 = Less than once a week

2 = Once or twice a week

3 = Three or more times a week

- 5. During the past month, how often have you had trouble sleeping because you...
 - a. Cannot get to sleep within 30 minutes
 - b. Wake up in the middle of the night or early morning
 - c. Have to get up to use the bathroom
 - d. Cannot breathe comfortably
 - e. Cough or snore loudly
 - f. Feel too cold
 - g. Feel too hot
 - h. Had bad dreams
 - i. Have pain
 - j. Other reason(s), please describe
- 6. During the past month, how would you rate your sleep quality overall?
 - 3 = Very good
 - 2 = Fairly good
 - 1 = Fairly bad

0 = Very bad

7. During the past month, how often have you taken medicine to help you sleep (prescribed or “over the counter”)?
8. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?
9. During the past month, how much of a problem has it been for you to keep enough enthusiasm to get things done?

0 = No problem at all

1 = Only a very slight problem

2 = Somewhat of a problem

3 = A very big problem

Morningness-Eveningness Questionnaire (adapted from Horne & Östberg, 1975)

Which one of these types do you consider yourself to be?

- a. Definitely a “morning person”
- b. Rather more a “morning person” than an “evening person”
- c. Rather more an “evening person” than a “morning person”
- d. Definitely an “evening person”

Sleep (morning):

Pittsburgh Sleep Quality Index (adapted from Buysse, Reynolds, Monk, Berman, & Kupfer, 1989)

1. What time did you go to bed last night?
2. Did you fall asleep within 30 minutes?
3. Did you wake up in the middle of the night or early morning?
4. What time did you get up this morning?
5. How many hours of actual sleep did you get last night? (This may be different than the number of hours you spent in bed.)
6. How would you rate your sleep quality overall?
 - a. Very good
 - b. Fairly good
 - c. Fairly bad
 - d. Very bad

Cognitive-Behavioral Insomnia Therapy Sleep Log (adapted from Edinger, 2016)

1. How rested did you feel when you woke up today?
 - a. 1 = not at all rested
 - b. 2 = slightly rested

- c. 3 = somewhat rested
- d. 4 = rested
- e. 5 = well rested

Sleep (evening):

Pittsburgh Sleep Diary (adapted from Monk et al., 1994)

How many naps did you take today?

If you took a nap today, about when did your longest nap start and end?

Appendix C: Ecological momentary intervention components

Motivational messaging (random time between 12-6 p.m.)

Day	Date	Motivational message	Type
1	Mon 3/27	Think about what encourages you to handle stress better.	MI
2	Tue 3/28	Remember, there are aspects of every situation that are inside of your control	PC
3	Wed 3/29	A simple way to get present is to take a few slow, deep breaths. Breathe in for 4 counts, breathe out for 8.	MF
4	Thu 3/30	Red light: Stop and breathe. Yellow light: Slow down, think of other possible reactions. Green light: Choose a wise reaction.	MF
5	Fri 3/31	Think about the actions you listed on your last present control written exercise. You can do them!	PC
6	Sat 4/1	Slow down and notice the feelings and sensations that are coming up for you right now.	MF
7	Sun 4/2	If you're worrying about the future, focus on the things you can control right now	PC
8	Mon 4/3	Think about what makes you confident that you can handle stress better.	MI
9	Tue 4/4	If you're feeling upset, remember the stoplight metaphor: Red: Stop; Yellow: Observe; Green: Proceed wisely.	MF
10	Wed 4/5	Think about the personal strengths you can draw on right now.	MI
11	Thu 4/6	Relax and breathe to slow yourself down any time you are feeling stressed	MF
12	Fri 4/7	If you're dwelling on the past, focus on what is under your control now.	PC
13	Sat 4/8	Looking at the things that you can control about your life right now, think about what actions you can you take.	PC
14	Sun 4/9	Think about what helps you focus on what you can control.	MI

MI = Motivational interviewing. PC = Present control. MF = Mindfulness.

Reminders (random time between 6-9 p.m.)

Day	Date	Reminder
1	Mon 3/27	We will start gradually uploading videos and audios on the app tomorrow. Be sure to check back!
2	Tue 3/28	The video of Dr. Frazier discussing present control and mindfulness is now up on the app for you to review whenever you'd like.
3	Wed 3/29	Check on the app for the written exercise on STOP and present control for you to use whenever you need it.
4	Thu 3/30	Mindfulness audios are now on the app! To practice monitoring and observing what's going on around you, check out the Simply Listening audio on the app.
5	Fri 3/31	For practice mindfully breathing, check out the Finding The Breath audio on the app.
6	Sat 4/1	Check on the app for the written exercise on STOP and present control, for you to use whenever you need it.
7	Sun 4/2	Check out the app for a different videos, audios, and written exercises to review.
8	Mon 4/3	There will be a new video with Dr. Frazier tonight with your evening survey. Don't miss it!
9	Tue 4/4	The video of Dr. Frazier discussing problem solving around focusing on present control is now up on the app for you to review whenever you'd like.
10	Wed 4/5	Check on the app for this week's written exercise on STOP and present control for you to use whenever you need it.
11	Thu 4/6	For practice noticing your thoughts without reacting, check out the Thoughts Are Only Passing By audio on the app.
12	Fri 4/7	For practice noticing your emotions without reacting, check out the Labeling Emotions audio on the app.
13	Sat 4/8	Check on the app for written exercises on STOP and present control, for you to use whenever you need it.
14	Sun 4/9	Check out the app for different videos, audios, and written exercises to review.

Written exercises on present control (adapted from Hintz, Meredith, & Frazier, 2015; Nguyen-Feng et al., 2016; Harris, 2009; Burdick, 2013)

Week 1, Times 1 and 2, Week 2, Time 1:

Think back to what has been bothering you the most recently. It can be something that you described today or something else.

STOP. Red light: Take a few deep cleansing breaths. Practice breathing in for 4 seconds, exhale for 8 seconds. Do this 3-4 times.

1. Yellow light: Slow down and observe. What feelings, thoughts, and bodily sensations come up for you when you think about this?

2. What aspects of this situation are out of your control?
3. What aspects of this situation can you control? Remember that in every situation, there are things that you can control even if it is only your reaction.
4. Green light: Take action. Looking at the things you can control, are there specific actions you can take? If so, list them here. If you have several action items, it may be helpful to prioritize them.

If you catch yourself worrying about any of the things you can control, remember to STOP, acknowledge the thoughts and choose an effective response. Remind yourself that you have a plan for dealing with them.

We all sometimes worry about the things we can't control. Again, STOP, acknowledge the thoughts and remind yourself that worry won't change the situation. Relax and breathe to slow yourself down, any time you are feeling stressed

All other weeks:

Think back to what you described as bothering you the most recently.

STOP. Red light: Take a few deep cleansing breaths. Practice breathing in for 4 seconds, exhale for 8 seconds. Do this 3-4 times.

1. Yellow light: Slow down and think. What aspects of this situation are out of your control?
2. What aspects of this situation can you control?
3. Green light: Take action. Looking at the aspects of the situation that you can control, what specific actions can you take? Remember that in every situation, there are things that you can control even if it is only your reaction.
4. Think about the actions you listed on your last present control written exercise. Which of those have you been able to do?
5. What has changed about the stressor as a result of the action you have taken?

If you catch yourself worrying about any of the things you can control, Remember to STOP, acknowledge the thoughts and choose an effective response. Remind yourself that you have a plan for dealing with them.

We all sometimes worry about the things we can't control. Again, STOP, acknowledge the thoughts and remind yourself that worry won't change the situation. Relax and breathe to slow yourself down, any time you are feeling stressed

Audios available on mobile application (Pollack, Pedulla, & Siegel, 2014)

Monitoring and acceptance: Simply listening

- Start by sitting comfortably, eyes either slightly open or gently closed.
- Allow yourself to simply listen to the sounds around you. Notice the sounds of the traffic, the wind, the rain, or the birds.

- There is no need to name the sounds, to grasp or hold on to them, or to push them away.
- Just allow yourself to listen to the sounds as they are.
- Imagine that your body is a gigantic ear, or if you prefer, a satellite dish, picking up 360 degrees of sound—above, below, in front, behind—all around you. Listen with your entire being.
- Notice that each sound has a beginning, middle, and end.
- If your mind wanders, no problem. Just bring it back to the present moment.
- Let yourself rest in the sounds of the moment, knowing that this moment is unique and that this constellation of sounds will never be repeated.
- Take a deep breath, wiggle your fingers and toes, stretch, and open your eyes if they have been closed. Try to extend focused attention into your next activity.

Mindfulness breathing meditation: Finding the breath

- Start by sitting comfortably, assuming a posture of dignity with your back straight, your spine relaxed but not rigid, eyes either softly open or closed.
- Find your breath. We are often so busy that we don't realize that we are breathing. Simply notice your breath.
- See where you feel your breath most strongly. It may be at the nostrils, at the chest, or in the belly. Allow yourself to feel the sensations of each inhalation and exhalation.
- If your mind wanders, no problem. Give yourself permission to begin again.
- Gently, kindly bring yourself back. Let the breath become your anchor, your friend. Rest in your breath.
- Don't be too ambitious; take it slow. We all have the ability to feel one breath completely.
- When you are ready, stretch, wiggle fingers and toes, and open your eyes if they have been closed. Try to extend focused attention into your next activity.

Body: Hands

- Let your hands rest in your lap. Bring your awareness to them, feeling them from the inside (the muscles and bones) to the outside (the skin and nails).
- Bring your attention to any sensations that you notice either inside your hands or where they touch your skin or your clothing. Allow your hands to settle into the stillness, not grasping anything, not pushing away anything.
- Become curious about what happens in your body when you allow your hands to rest. Bring your awareness to any sensations, thoughts, and feelings that you notice. Allow any desires (for example, for food, a substance, entertainment) to arise and pass away.
- Keep returning your attention to your hands, feeling any and all sensations that arise. Let your hands be just as they are in this moment.

Body: Soles of the feet

- Start by rocking back and forth, from the heels to the toes, and then side to side. Wiggle your toes.
- If you like, raise one foot and then the other, as if you are marching.

- Feel your feet resting firmly on the ground. Notice all of the different sensations. Feel the soles of your feet.
- If you like, imagine that there are roots underneath each foot, anchoring and grounding you. Let yourself feel connected to the earth.
- If you get distracted, simply return to feeling the soles of your feet.

Body: Walking meditation / Anchoring in the body

- Stand comfortably with your eyes open, feet about hip distance apart, weight evenly divided between the feet. Arms can be at your sides, behind you, or in front of you—whatever feels most comfortable. Let yourself feel connected to the ground.
- Become aware of any sensations in the toes, soles, and heels. Feel free to shift your weight between the feet to make these sensations clearer.
- Start walking slowly, remaining relaxed and alert. Feel your feet touching the ground.
- Silently note to yourself “touching, touching.”
- Bring attention to each movement of walking—lifting, moving, placing.
- Notice what is happening around you but keep your focus on the sensation of walking.
- If you find you’re able to attend with some continuity to the sensations in your feet and legs, let your awareness expand to take in the light, colors, sounds, and smells around you. Notice whatever predominates in your awareness. No control, no effort, no explicit focus.
- If you get overwhelmed, or if your attention gets hijacked by trains of thought—no problem, bring yourself back to the feeling of your feet touching the ground.
- When you are ready to stop, return to your breath, the feeling of your feet on the ground, and stretch.
- See if you can carry this awareness into your next activity

Awareness of thoughts: Thoughts are only passing by

- Once you feel grounded and centered, bring your attention to your thoughts. Watch the thoughts as they arise, imagining them as clouds passing through the sky. Some are fluffy cumulus, others are dark and stormy. Sometimes there are few clouds, other times the sky is totally clouded over.
- Let them all pass by. Know that you are not the thoughts. See if you can imagine yourself as the vast and spacious sky that is holding all this constantly changing weather.
- A variation is to visualize that you are at a beach where the sand and water meet. Let yourself rest there for a minute watching the waves come and go. Inhale. Notice the smell, the sounds, the rhythm of the ocean. Take a stick or a rock and write down any anxious or ruminative thoughts in the wet sand. Watch as a wave comes and the words disappear into the wet sand.
- Let the clouds be clouds (or the waves be waves). As Zen masters say, thoughts are “real but not true.” Let the thoughts pass by and disappear without clinging to them.

Awareness of feelings: Labeling emotions

- Start by sitting comfortably, eyes either closed or partially open. Take a few deep breaths, or if you prefer, bring your attention to the sounds around you.
- Spend a few moments connecting with your anchor. When you are taken away by an emotion, note what the emotion is. With an attitude of warmth and acceptance, label the emotion. For example, note, “worry, worry, worry.” Don’t obsess about getting the label exactly right. It doesn’t need to be precise to be effective.
- See where you find this emotion in your body. Allow yourself to simply be with it.
- Notice the attitude you bring to this practice. Are you yelling at yourself when you notice “anger, anger, anger”? Are you telling yourself that you’re a bad person for having this emotion? See if you can label with kindness, warmth, and acceptance.
- If the emotion becomes too intense and you start to get overwhelmed or lost in it, simply return to your anchor.
- There is no need to hold on to or analyze the emotion. Let it rise and fall away. No need to go into the history or story behind the emotion either. Label it and let it go.
- Label the emotions with as much warmth and kindness as possible. If you feel that negative emotions don’t deserve kindness, label this as well. Be open to pleasant emotions and label them too.
- Continue to alternate between labeling the emotions and grounding with your anchor. When you’re ready, take a few deep breaths, wiggle your fingers and toes, stretch, and open your eyes if they have been closed. Try to continue to be aware of your emotional reactions as you move into your next activity.

Appendix D: Study timeline

Spring 2017

- Post institutional review board approval
 - Participant recruitment
 - Mon 3/20 to Fri 3/24
 - Participants complete training confirmation and pretest
 - Sat 3/25 to Sun 3/26
 - Research team randomizes participants to 1 of 2 conditions; Participants download smartphone application.
 - Mon 3/27 to Sun 4/9
 - Participants complete 1 of 2 conditions outlined below
 - Mon 4/10 to Sun 4/16
 - Participants complete posttest
 - Fri 4/28 to Fri 5/5
 - Participants complete follow-up
- 1) Ecological momentary intervention (EMI) condition
- Mon 3/27 to Sun 4/9
 - Availability of written exercises on present control and mindfulness exercises as well as rationale of intervention components with evening assessment
 - Daily motivational messages at random point between 1 p.m. and 6 p.m.
 - Daily reminders of smartphone app tools at random point between 6 p.m. and 9 p.m.
 - Daily morning assessment at 9 a.m. to 12:59 p.m.
 - Daily evening assessment at 9 p.m. to 12:59 a.m.
 - Week 1: Mon 3/27 to Sun 4/2
 - Mon 3/27: Video on how stress affects college students with evening assessment
 - Tue 3/28, Thu 3/30, Sun 4/2: Intervention activity following evening assessment
 - Week 2: Mon 4/3 to Sun 4/9
 - Mon 4/3: Video on different aspects of control and benefits of present control
 - Tue 4/4, Thu 4/6, Sun 4/9: Intervention activity following evening assessment
- 2) Ecological momentary assessment (EMA) condition
- Mon 3/27 to Sun 4/9
 - Daily morning assessment at 9 a.m. to 12:59 p.m.
 - Daily evening assessment at 9 p.m. to 12:59 a.m.
 - Week 1: Mon 3/27 to Sun 4/2
 - Mon 4/3: Video on how stress affects college students with evening assessment

- Week 2: Mon 4/3 to Sun 4/9
 - No additional information

	EMI	EMA
Mon 3/20 to Fri 3/24	Complete training confirmation and pretest	
Sat 3/25 to Sun 3/26	Research team randomizes participants to 1 of 2 conditions; Participants download smartphone application	
Week 1: Mon 3/27 to Sun 4/2	<p>Availability of written exercises on present control and mindfulness exercises</p> <p>Daily motivational messages at random point between 1 p.m. and 6 p.m.</p> <p>Daily morning assessment at 9 a.m. to 12:59 p.m.</p> <p>Daily evening assessment at 9 p.m. to 12:59 a.m.</p> <p>Mon 3/27: Video on how stress affects college students as well as rationale of intervention components with evening assessment</p> <p>Tue 3/28 to Sun 4/2: Intervention following evening assessment</p>	<p>Daily morning assessment at 9 a.m. to 12:59 p.m.</p> <p>Daily evening assessment at 9 p.m. to 12:59 a.m.</p> <p>Mon 4/3: Video on how stress affects college students with evening assessment as well as benefits of self-monitoring</p>
Week 2: Mon 4/3 to Sun 4/9	<p>Availability of written exercises on present control and mindfulness exercises</p> <p>Daily motivational messages at random point between 1 p.m. and 6 p.m.</p> <p>Daily morning assessment at 9 a.m. to 12:59 p.m.</p> <p>Daily evening assessment at 9 p.m. to 12:59 a.m.</p> <p>Mon 4/3: Video on different aspects of control and benefits of present control with evening assessment</p>	<p>Daily morning assessment at 9 a.m. to 12:59 p.m.</p> <p>Daily evening assessment at 9 p.m. to 12:59 a.m.</p>

	Tue 4/4 to Sun 4/9: Intervention following evening assessment	
Mon 4/10 to Sun 4/16	Complete posttest	Complete posttest
Fri 4/28 to Fri 5/5	Complete follow-up	Complete follow-up